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THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE
PROGRESSIVE DISCOVERIES AND IMPROVEMENTS
IN THE
SCIENCES AND THE ARTS.

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JANUARY APRIL 1862.

VOL. XV. NEW SERIES.

EDINBURGH:

ADAM AND CHARLES BLACK.

LONGMAN, BROWN, GREEN, & LONGMANS, LONDON.

MDCCLXII.



52946

EDINBURGH:
PRINTED BY NEILL AND COMPANY, OLD FISHMARKET.

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THE

EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

On the Chemical Geology of the Malvern Hills. By the Rev.
J. H. TIMINS, M.A. of Trinity College, Cambridge, Vicar
of West Malling, Kent.

The constitution of the rocks of the Malvern Hills is a subject of much interest to the geologist, but its complete investigation is a work of some difficulty. As stated by Professor Phillips, there are in the chain "granite, syenite, greenstone, hornblende rock, felspar rock, serpentinous rock, epidotic rock, and other nameless products of igneous action. A rock which cannot be technically distinguished from gneiss is abundant, and some varieties might receive the name of chloritic, and even micaceous schist. But the manner in which all these are associated, and some of them graduate into others, is so perplexing, and the phenomena are so continually and variously repeated, even in very limited tracts of the mountain, as to demand the utmost care in reasoning on their probable origin."

A systematic analysis of the several rocks in different parts of the chain may help to remove the obscurity in which this question is involved; and it may furnish important information as to the chemico-physical processes which have resulted in the development of the older crystalline rocks, the sources from which they have been derived, and the nature of the metamorphic influences to which they have been exposed.

Although the study of the Malvern rocks is frequently made very difficult by varied and unequal crystallizations and extensive segregations, there are, notwithstanding, in all parts of the hills, rocks in which the components are distributed with tolerable uniformity throughout the mass. I propose to consider these in the first instance; and when their consti-

tution shall have been fully determined, we shall have less difficulty in forming an opinion as to the origin of rocks of a less simple character.

We find, on examination, that in many of these rocks, the ratio of the oxygen of the silica to that of the bases is as 3 : 2, which corresponds to that of aluminous augite and of labradorite, and of course also to any combination of the two. This is the ratio assigned by Bunsen to one principal division of the characteristic eruptive rocks of Iceland. We meet with rocks of this ratio in all parts of the Malvern Hills, and under various forms. Thus, in a fine-grained mixture of hornblende and epidote in the North Hill (xii.); in a red rock, with epidote and gold mica, further south (xiii.); in a grayish black rock forming a vein in the syenite over West Malvern (x.); in a similar rock from the railway tunnel, under the South Hill (xi.); in some of the peculiar traps of the West Ragged stone, and of the dykes at its base (xiv. xx.), the ratio of the oxygen of the silica to that of all the bases taken together is nearly as 3 : 2. In other rocks, this ratio is as 3 : 2½, as we find it to be in some bosses of trap on the hill above Bransill Castle (xv. xvi.), and in the rocks of the large quarry between North Malvern and West Malvern (i.-iv.) And other rocks have an intermediate composition, so that we pass, by scarcely perceptible gradations, from one of these classes to the other; and this variation is found to prevail as much amongst those rocks which closely resemble each other in appearance as amongst those which are dissimilar. It should be observed that many of these rocks bear evidence of some alteration from their original composition: the quantity of water contained in them being large, and portions of their silica as well as of their bases being found deposited in their fissures and cavities.

The accompanying table will show the result of the analysis of some of these rocks taken from various parts of the chain. The *first* line gives the quantity of silica found in *all* the ingredients of the rocks, including *water*; the *last* line gives the percentage of silica *after ignition*. This is slightly underrated (in no case by more than 1 per cent.), owing to the increase in the weight of the ignited rock by the higher oxidation of the iron.

Analyses of Rocks taken from various parts of the Malvern Chain.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.
Silica, ...	43.71	43.81	44.67	42.87	44.77	45.33	45.04	46.23	43.33	47.63	48.71	49.77	49.08	48.97	40.00	39.25	43.63	42.30	44.25	48.25	48.64
Alumina, ...	18.33	20.50	20.40	17.50	17.30	19.10	18.61	17.65	15.40	16.64	20.75	19.73	21.65	18.75	18.15	15.26	13.48	20.24	21.75	21.42	15.35
Peroxide of Iron, . .	18.81	17.68	16.11	...	18.88	15.71	16.72	14.75	16.93	14.98	15.90	13.10†	...	7.53†	12.44	12.97	12.23	10.93	9.05†	8.47	8.59
Peroxide of Iron, . .	1.25	2.00	0.75	21.23†	...	1.75	trace	trace	0.75	...	...	...	11.05	...	...	...	...	...	...	...	...
Oxide of Manganese, .	0.55*	0.75	0.60*	0.25	0.30	0.75	0.50	0.75	2.00	0.90	1.25	0.70	0.80	1.10	1.50	1.50	1.75	0.75	1.10	1.00	1.75
Lime, ...	5.25	5.10	6.36	4.99	5.80	5.75	6.25	5.34	6.30	8.46	5.70	9.46	7.85	5.18	6.70	6.97	10.22	3.20	4.60	3.85	2.31
Magnesia, ...	3.15	3.44	2.15	2.62	4.15	2.10	4.12	5.15	4.19	4.37	3.82	2.66	2.87	4.57	7.40	9.87	7.30	10.41	3.74	5.45	3.23
Loss at 212°, ...	3.12	2.22	2.07	1.50	1.06	1.29	0.50	1.57	1.80	0.58	0.80	1.42	1.40	1.82	2.07	3.52	1.70	3.51	4.78	1.98	3.22
Loss on ignition, . .	1.65	1.30	...	3.05	2.26	4.71	3.10	3.10	4.15	3.00	1.00	1.75	2.70	4.78	7.27	5.51	5.53	5.53	3.61	4.36	3.77
Potass, ...	1.10	3.20	1.20	5.99	5.48	3.51	0.50	5.45	5.15	3.44	0.18	1.40	0.33	7.30	4.47	5.15	4.26	3.08	7.12	2.60	0.15
Soda and Loss, . . .	3.08	5.69	5.69	...	...	4.66	...	...	...	...	1.89	...	2.47	...	...	...	...	...	...	2.60	2.93
Percentage of Silica after ignition, . . }	45.90	45.40	45.61	44.91	46.31	48.22	46.72	48.49	46.07	49.40	49.60	51.39	51.18	52.44	44.12	43.14	46.92	46.53	48.30	51.52	52.05

* With some Oxide of Copper.

† With some Protoxide.

‡ With some Peroxide.

I. Rock from a large quarry between North Malvern and West Malvern, disposed in horizontal tabular masses. Formerly broad slabs were obtained from hence, which were extensively used in the railway works; but these have been removed, and the rock which remains is loose, separating readily in nearly vertical lines. It is superficially stained with hydrated peroxide of iron. The iron in the interior of the rock is generally in a low state of oxidation, but some of it is in the form of anhydrous peroxide. There is much sulphate of baryta in this and in other quarries to the north of it. The rock, although easily fusible, is not altered where in contact with it: crystals of calc spar are found intermingled with it; and where the fissures are large, they are not filled by the sulphate of baryta, which is deposited in crystals on the opposite surfaces, leaving a vacant space of several inches between them. The sulphate of baryta cannot, therefore, have been injected into these fissures in a molten state after the consolidation of the rock. Baryta was not detected in the substance of the rock itself, which, when dissolved, after fusion with carbonate of soda, gave no precipitate with diluted sulphuric acid. This and the other rocks of which analyses are here given contain hydrofluoric acid, which cannot be completely eliminated by heat; after having been ignited until fusion of the rock had commenced, the presence of fluorine was still detected in it by fusion with bisulphate of potassa. This rock is uncrystallized, but it passes into syenite and mica schist.

II. Syenite, from the same place. The crystallization is imperfect, and some anhydrous peroxide of iron remains in an earthy state.

III. Amorphous rock from the same place, passing into mica schist. It differs from I. in having a smooth surface when fractured, and in being more of a slate colour than the latter. After being dried by evaporation at 212° Fahr., it gained 0.87 per cent. in weight by subsequent ignition, owing to the peroxidation of the iron.

IV. Hard mica schist, into which the above passes. The mean composition of these two agrees more nearly with the uncrystallized rock in the quarry (I.) than the composition of either of them taken separately. There may have been an

interchange of elements, some of the iron and magnesia in the mica of IV. having been derived from III., which retains a larger proportion of alumina, lime, and manganese.

V. Brownish grey rock, from the summit of the same quarry, uncrystallized, disposed in beds with vertical cleavage, similar to the rock below.

VI. Syenite from the same place, similar to II., but more fine grained.

VII. Greyish black rock, disposed in rectangular prisms, on the west slope of the North Hill, at a higher elevation than the preceding, and to the S.W. of them, quite uncrystallized, but passing into syenite.

VIII. Syenite, associated with the above; its chief constituent is hornblende. It is more perfectly crystallized than the syenites before mentioned (II. VI.) Thin veins of epidote are deposited in its crevices. The portion of the syenite of which an analysis is here given was taken from a part of the rock which did not contain any admixture of epidote.

Comparing I. and II., III. and IV., V. and VI., VII. and VIII., we find instances of the transition of rocks from the amorphous to the crystallized state, without any material change of composition; and as syenites and mica schists similar to these are found in other parts of the hill, we may thus trace them to their source, even where no amorphous rocks occur in their vicinity.

IX. Greyish black uncrystallized rock, forming rectangular prisms, south of the large quarry at North Malvern. It contains much hydrofluoric acid, and is very fusible. There is only a trace of soda.

X. Greyish black rock, forming a remarkable vein in the syenite north of the footpath from Great Malvern to West Malvern, overlooking the Westminster Arms. The vein dips slightly southward; it is about twelve feet long, and from a few inches to more than a foot deep; broken by a fault towards the north. Near the syenite it is marked by epidote; the interior is hard, compact, and uniform.

XI. A similar rock, taken from the middle of the railway tunnel under the South Hill.

In these two rocks, the ratio of the oxygen of the silica to

that of the bases is nearly 3 : 2. There is less silica in VII., and still less, in IX. Yet these four rocks closely resemble each other in appearance. The rock containing least silica (IX.) has most water, and is probably most altered from its original composition; its alumina is reduced in quantity, and its soda nearly removed.

XII. Rock forming rectangular prisms, consisting of fine-grained hornblende and epidote, from the west slope of the North Hill, near the summit, overlooking the hill road north of Elrington Cottages.

XII. Red rock, from a steep mound overlooking the south end of the road to Elrington Cottages. It is very hard, and spotted with epidote, and there are minute scales of gold mica. There is only a trace of hydrofluoric acid. All the iron is in a high state of oxidation. It passes into a coarse rock, containing much quartz; and in one place, towards the south, it is associated with a rock which runs in parallel bands, about four inches wide, and five inches apart, resembling metamorphic sandstone.

XIV. Rock found in rectangular prisms in a boss of trap near Fowlet Farm, of a greenish-brown colour, uncrystallized, with numerous cavities, which are partially lined with epidote. In the furnace, when allowed to cool rapidly, it fused into a black glass, like obsidian.

XV. Greyish black amorphous rock, from a trap boss near Bransill Castle. The cavities are filled with carbonate of lime.

XVI. Rock from another boss near Bransill Castle, in which are embedded velvet black portions, apparently of augite, but with no distinct crystallization.

XVII. Similar rock, from a boss of trap, in a field of black shale south of Fowlet Farm. It contains a little glassy felspar. The quantity of hydrofluoric acid is unusually large.

XVIII. Grey trap rock, from a boss near Rowick, containing magnetic oxide of iron.

XIX. Trap rock from the south-west base of the Ragged Stone Hill. The iron in the part of the rock which is soluble in hydrochloric acid is in a low state of oxidation; the insoluble portion contains a little peroxide.

XX. Trap from the north-west side of the West Ragged Stone. The portion soluble in hydrochloric acid contained magnetic oxide and protoxide of iron; the insoluble portion, peroxide.

XXI. Rock from the same place, after passing over the sandstones, and immediately before arriving at the trap of the hill. It contains black granules, like gunpowder. There are in it hydrofluoric acid and a little potass, but no soda; and it seems to consist of minutely divided hornblende and quartz.

On Nerve Force. By H. F. Baxter. (Continued from Vol. XII. p. 39.)

In a former paper, published in the "Edinburgh New Philosophical Journal,"* I endeavoured to ascertain whether any manifestation of current force could be obtained in nerves during nerve action. My experiments led to a negative conclusion; neither could I obtain any direct evidence of an *increase* in the nerve current *during* nerve action; but whether any evidence of a *conversion*, as it were, of the electric force of the nerve into nerve force during nerve action existed, remained as an open question. My object, however, on the present occasion, will be to inquire whether we can obtain any evidence of an inductive effect of one nerve upon another nerve during nerve action.

Claude Bernard† says, "Du Bois Raymond has proved that in electrifying the nerves, an electro-tonic state is produced, which does not act upon the muscles, but upon the nerves which lie in the vicinity; they are liable, in fact, to receive a part of the superabundant electricity condensed in the neighbouring trunk. Let it be supposed, for instance, that a current passes through a nerve, which lies in contact with another divided nerve, contractions will appear in the muscle connected with this latter branch, although no direct impulse has been conveyed to it; the proximity of another nerve,

* New Series, July 1860. I may also refer to my Essay on Organic Polarity, published by Churchill.

† Medical Times and Gazette, August 17, 1861.

strongly impregnated with the electric fluid being sufficient to create a participation in its effects."

M. Chauveau,* in some valuable and interesting papers, has shown that when the nerves of two separate limbs are placed parallel and in contact with each other, upon stimulating one of them the limb of the other would contract. The effects varied according as the electric current traversed the nerve, and it was necessary to employ electricity.

Having failed in my former experiments in obtaining any evidence of an *increase* in the electric condition of the nerve after being submitted to electrical action, the opinion expressed by Claude Bernard, that "one nerve received a part of the superabundant electricity condensed in the neighbouring trunk," does not appear to me to be supported by sufficient evidence, but would rather confirm the notion that some inductive effect might then be produced.

In the following experiments the nerve of the limb *primarily* stimulated will be designated by the letter *a*, and the nerve of the other limb,† in which any inductive effect may be supposed to take place, such as would be indicated by muscular contraction, will be designated by the letter *b*.

M. Chauveau dissected out the sciatic nerves of a frog, removed the thigh, leaving the nerve connected with the leg only; then placing the nerves parallel to each other and in contact, stimulating a portion of the nerve *a* by means of a current from a small voltaic circle between the leg and the part in contact with *b*, an effect was produced on the nerve *b*, as indicated by muscular contraction of that limb. The effects varied according as the nerves were placed in contact with each other, whether in the same direction or reversed, and according to the direction of the current, whether ascending or descending. The distance between the stimulated portion of

* Journal de Physiologie, Juillet et Octobre 1859, Janvier et Avril 1860.

† The limb *b* has been usually designated as the *rheoscopic* or *galvanoscopic* limb. I shall avoid using either of these terms on the present occasion, inasmuch as my object is not to ascertain whether any electrical effect is observed, but whether any effect like nerve induction takes place, just as we obtain an inductive effect when a closed metallic circle is placed in the neighbourhood of another closed circle traversed by an electric current.

a and *b*—the extent of contact between *a* and *b*—were points necessary to be attended to.

As my experiments confirmed in the main the results obtained by M. Chauveau, it will be unnecessary to enter into a detailed account of them, especially as the effects observed appear to me to be referable to other causes than the one sought for—viz., an inductive effect. They were conducted in the following manner.

The nerves of the thigh and pelvis were carefully dissected out with the leg remaining. With the two limbs thus prepared and separated, a long portion of the nerve *a* could be placed in contact with *b*, the limbs being in the same direction or reversed, or the nerve *a* was coiled round the nerve *b*. Whenever the spinal extremity of *a* was stimulated by a small voltaic circle, such as a piece of zinc and copper wire, and the end of *b* in contact with *a*, although at some distance from the excited extremity of *a*, contractions were produced in both limbs, provided that both limbs were fresh and easily excited, and the limbs in the same direction. If the nerve *b* was arranged with its spinal extremity near the leg of *a*, the limb being in the reversed direction, contractions were occasionally produced in *b*. If the spinal extremity of *b* was bent out so as not to be in contact with *a*, then the effects, the contractions of the muscles of *b*, were not so readily produced. If a stronger exciting force was employed—viz., the electricity from one of Grove's middling-sized cells, the effects were more readily obtained, but of the same character.

Instead of exciting the nerve *a* by means of electricity other steps were adopted, such as the point of a needle, or a piece of glass, or by applying solution of caustic potash, or of common salt, to the nerve. Under these circumstances contractions were readily excited in the limb *a*, but rarely in *b*.

I now prepared two frogs with the limbs attached to the spinal cord; the nerves were dissected out, and the pelvis and thighs removed. The nerves *a* were coiled round or placed in contact with the nerves *b* as before, and I could thus act upon four limbs together or separate, or I could make one limb contract and its corresponding limb contract also by

reflex action. In this experiment I very rarely obtained any contraction in the limb *b*.

From the results obtained in all my experiments, I cannot come to the conclusion that any inductive effect was obtained indicative of *nervous induction*; and although it sometimes happened that an effect did occur which might lead one to conjecture that such might be the case, I must nevertheless confess that the evidence was not sufficiently strong to justify me in coming to that conclusion. I shall now briefly recapitulate the circumstances to which the results appear to me to be due.

The contractions observed in the limb *b* may arise from various circumstances—those which are *extrinsic*, and from those which are *intrinsic*. The former are—*1st*, The *nerve-current*. The position of the nerves may be so arranged that the nerve-current is either made or broken from the slightest movement of one of the limbs,—a circumstance which is very likely to occur during the contraction of the muscles. The nerve-current may not arise from or be excited at the extremity of the nerve, but at one of the divisions of the trunk of the nerve, which went to supply the muscles of the thigh.

2dly, From the electricity evolved during the contraction of the muscles in limb *a*—this electricity being conducted by the nerve itself, just as we find it to occur when the nerve is placed on the contracting muscle. That electricity evolved during the contraction of a muscle may be made to traverse a circuit not composed of animal matter, has been shown by Matteucci; and some experiments of my own have led me to similar conclusions.

3dly, From the contact of heterogeneous substances. If a portion of muscle or some blood be in contact with either of the nerves, we may have a current of electricity developed due to the contact of heterogeneity, or to the muscle itself producing a muscular current. It is requisite to pay particular care and attention to the nerve at its junction with the leg. A muscular current may be easily generated at this spot.

4thly, From the electricity employed to arouse the contractions in limb, *a*. If the nerve *b* be near to the excited por-

tion of *a*, contractions are readily produced in *b*. This effect I refer to the electric influence extending to the nerve *b* being conducted by *a* to *b*.

5thly, The slight and occasional effects which cannot be referred to either of the four previous circumstances may be referred to a change of condition (electric) in the nerve *a*. The effects are too rare to be referred to a definite and permanent cause, such as nerve-induction, and too uncertain in their production to be considered as cause and effect, and are evidently the result of some occasional disturbance in the conditions of the experiment. That the electric condition of the nerve is altered when the nerve is irritated mechanically or chemically is easily shown by the galvanometer, by a decrease in the nerve current; and as the effects may occur when electricity is not employed to excite the nerve *a*, I cannot see how they can be referred to "a part of the superabundant electricity condensed in the neighbouring trunk." I shall state other arguments against the supposition of these effects being the result of nerve induction; but prior to doing so, I must just refer to the contractions which may arise in the limb of the nerve *b* independent of those excited by its contact with the nerve *a*, and which may be termed *intrinsic*. These may arise, 1st, from the nerve *b* itself becoming dry, as shown in the experiments of Marshall Hall;* or, 2dly, from a peculiar state or condition of the limb itself, as may be seen in frogs during the period of spawning, when tetanic contractions are easily produced in the muscles. How far this tetanic state is due to the muscles or to the nerve it is difficult to say; but the fact itself must be taken into consideration, when using the frog as a test of any extrinsic influence.

Thinking it possible that some inductive effect might occur with an electric current, I passed a current from eight of Grove's middling-sized cells parallel to the sciatic nerve, in both directions and transverse to it, but without obtaining any effect when the circuit was made or broken. Matteucci† has also performed a similar experiment without obtaining any result.

* Edinburgh New Philosophical Journal, April 1848.

† Philosophical Transactions, 1845, p. 316.

Although these experiments have led to negative conclusions, we must not despair of obtaining more correct views in regard to nerve force. If we can only show that nerve force is not electric force, one great point will be gained; for nothing can be more injurious to the progress of sound knowledge than the confused notions which arise from the employment of terms which are apt to convey erroneous ideas. I will now endeavour to state as concisely as possible the views which I have been led to entertain in regard to nerve force; and however confident I may feel of their truth, I shall not consider them as peculiar to myself, or even that they are not open to remark.

Nerve force I believe to exist in a state of tension. It is not generated in one part and transmitted to another, but associated with the nervous tissue, and the impulse excited at one point is transmitted to another. Its action is not like that of a current of electricity, which depends upon its increase at the terminals, but bears a stronger resemblance to that of a magnet; its action is accompanied not by an increase but by a decrease of its power; the force is lowered, not raised, during nerve action. We have not any evidence at present to show that nerve force extends to a distance like magnetic force, nor can we obtain any inductive effect, as we do with a current of electricity. Now, this may arise from our not being able to *increase* nerve force. Nerve force is so intimately connected and dependent upon nutrition, the one being increased as the other is exalted or increased, that the only mode apparently of increasing nerve force is by exalting the nutritive actions. With regard to the dependence of nerve force upon the electric force, as it exists in the nerve, the latter in this respect is similar to all the other tissues; they all possess what may be termed an electro-tonic state, and I do not think that we have been enabled as yet to obtain any definite evidence of a *conversion*, as it were, of the electric force associated with the nerve into nerve force. The electric force may only indicate one of the conditions, a normal condition of the tissue; and therefore I cannot help considering it as somewhat objectionable in applying the term electro-tonic to the nerve, if it be intended thereby to indicate any peculiar state of the nerve, or that nerve force is

nothing more nor less than this electro-tonic state of the nerve. This is reducing nerve force merely to electricity. And with regard to the evolution of electricity in the fish, and during muscular contraction, nerve force is not converted into electricity; the electricity pre-exists in the muscular tissue and in the electric organ, as has been recently shown by Matteucci.* Nerve force and electricity are not convertible terms; and although no force can affect another without itself being affected, we are not justified in assuming that the reaction is of the same nature as the action. Electricity is evolved by nervous influence, and so far a connection or relation between these two forces exists. An evolution of electric power is accompanied with a loss of nervous power; but that a restoration of electricity to the organ would be accompanied with a restoration of nervous power, does not follow as a matter of course; at the same time, it is a question important to decide. The principle of the *conservation of force* is quite distinct from that of *conversion* of force. The former may be considered as an undoubted truth, the latter a theory: vital phenomena bear evidence to the truth of the former principle, that there is no exhaustion of power without a corresponding restoration. *Nutrition* is the grand restorative act during organic work.

In the application of the principle of the conservation of force to organic phenomena, it has been sometimes supposed that the animal body is a mere steam-engine; that the processes which take place in it are for the express purpose of producing *heat*; that the formation of carbonic acid in the lungs is solely for the generation of heat; that compounds are formed for the purpose of being burned, &c. That the development of heat in the animal body is an important fact no one can deny; its formation and connection with the evolution of carbonic acid in the lungs, and other chemical changes, are subjects worthy of research, so as to ascertain the ratio that one bears to the other; but to overlook the development of other forces which are manifested in the animal body, appears to me to be disregarding some of the most important facts

* Proceedings of the Royal Society, November 1860.

connected with vital phenomena. The animal body is something more than a mere mechanical machine, a mere steam-engine, or a mere chemical laboratory; the changes which take place in it subserve more important purposes, the development and manifestation of more recondite phenomena, which deserve and require much investigation for their elucidation.

Before concluding the present paper, I shall just refer to the action of electricity upon the nerves in exciting muscular contraction.

It is well known that contractions arise from the development of the nerve-current in the nerve of the limb,—that is to say, that when the extremity of the nerve is bent over so as to touch the side of the nerve, contractions are produced in the muscles supplied by that nerve. This experiment was known in Galvani's time. Contractions are also produced when the circuit is broken. To obtain these effects, the limb must be fresh and the frog easily excited. It is needless to add, that contractions may be produced by mechanical means, such as irritating the nerve with a needle or a bit of glass; also by chemical means, such as moistening the nerve with a solution of caustic potash, or of common salt, or with strong acids: so that electricity itself is not essential for the production of muscular contraction, but it would appear that a *change of state* in the nerve is the essential condition. Although electricity is not necessary for the production of this *change of state* (I am not supposing that the electric state of the nerve is not affected), it nevertheless bears a very important relation to nerve force in the production of this *change of state*, as is manifested in the difference of effects observed in regard to the *direction* of the electric current when made to traverse a nerve. Let us pass a current of electricity from a small voltaic circle along the nerve of a recently prepared frog; if the current be passed either in the *direct* or *inverse* directions, contractions are produced both at the *closing* and at the *opening* of the circuits. After a short time the effects (contractions) are produced only at the *closing* of the *direct*, and at the *opening* of the *inverse* current. I shall not enter upon the different results that are observed at various periods,

these have been noticed by Nobili and others, and especially by M. Chauveau. The results of my own observations lead me to believe that, after a short period, a series of constant results is not easily obtained, so that a doubt naturally arises whether any definite law can be laid down in regard to their production at distinct periods; nevertheless the facts, such as I have stated to occur at the *opening* and *closing* of the circuits, will not, I think, be denied; and the question arises, can they be referred to any principle of action? M. Chauveau* and Dr Radcliffe† suppose that muscular contractions are the result of instantaneous currents of high tension, the result of extra currents and induced currents formed at the opening and closing of the circuits. There can be no doubt that the *change of state* produced in the nerve occurs at these periods, and arises from an alteration in the electric tension of the circuits; but I believe also that the *direction* of the current traversing the nerve is of more importance. Let us suppose that we are acting upon a nerve after the first period of the excitability, when the effects (contractions) occur at the closing of the *direct* current, and not at its *opening*; and at the *opening* of the *inverse* current, and not at its *closing*. After the closure of the circuit, when the *direct* current is passing, we obtain contractions; but at its *opening* we then have an *inverse* current (the extra current), but no contractions. After the closure of the *inverse* current, no contractions; at its opening, we then obtain a *direct* current (extra current), and contractions are produced.

M. Chauveau has well pointed out the differences observed under these circumstances, but he speaks of the current as being stronger. Now, according to Faraday,‡ “the intensity and quantity of electricity moving in a current are smaller when the current commences, or is increased, and greater when it diminishes or closes;” such being the case, and if the results were due to high tension, we ought to have a greater effect at the *opening* of the *direct* current than at its *closing*, but experiment leads to an opposite conclusion. At the

* Journal de Physiologie, Janvier et Avril 1860.

† On Epilepsy, 3d edit., 1861.

‡ Experimental Researches, vol. i. para. 1107.

closing of the *inverse* current we get no effect; but at its *opening*, when we have the *direct* current (extra current), contractions are produced. From these facts, I cannot but infer that the *direction* of the current is of the utmost importance in these experiments; they go far to show an intimate connection between nerve force and electric force, but at the same time afford no proof of their identity.

The conclusions that are deduced from the foregoing experiments and arguments are,—

First, That no inductive effect is obtained during nerve action upon a neighbouring nerve.

Secondly, The contractions which are observed in the limb *secondarily* excited may arise from various circumstances, which may be divided into those which are *extrinsic* and those which are *intrinsic*. Amongst the former are, *1st*, The nerve-current; *2dly*, From the electricity evolved during the contraction of the muscles; *3dly*, From the extent of heterogeneous substances adhering to the nerve, or from a muscular current; *4thly*, From the electricity employed to arouse the contractions in the limb; and, *5thly*, From a change of condition (electric) in the nerve primarily excited. The *intrinsic* are, *1st*, The state of the nerve respecting its dryness; and, *2dly*, The state of the animal at the time of the experiment.

Thirdly, No inductive effect is produced upon the nerve when placed in the neighbourhood of a wire traversed by an electric current at the opening and breaking of the circuit.

Fourthly, That, in the application of the principle of *conservation of force* to the organic kingdom, other phenomena besides those connected with the development of heat and chemical action require to be studied; and,

Fifthly, In the action of electricity upon nerves to arouse muscular contraction, the *direction* of the current is of the utmost importance to be attended to.

Observations on the Natural History of the Enemies of the Coffee-Tree in Ceylon. By J. NEITNER, Esq., Ceylon.

In publishing these observations (which may be looked upon as a continuation of a general notice of noxious Ceylon insects, published by me in *Stettiner Ent. Zeitung* 1857), I have a two-fold object in view: first, the diffusion of a *correct* knowledge of the subject which they embrace amongst my brother planters, and secondly to furnish a contribution to biographical and economic entomology—a branch of the science which is now being daily more and more appreciated. In judging of apparently trivial passages as well as of scientific technicalities, which occur in the text, this must be borne in mind. To those of my brother planters who would have wished for more elementary explanations than space permitted me to introduce, I can strongly recommend “Westwood’s Introduction to the Modern Classification of Insects,” 2 vols., with numerous woodcuts, as a most excellent and inexhaustive source of information.

The numerical list given below might easily be doubled by minute research in the outlying districts, and introduction of unimportant species. However, such as it is, it holds good for the entire coffee region of Ceylon in general, and for the cluster of districts grouped round the Peacock-hill (my special field of research) in particular. In fact, the brown and white bug, and the black and white grub, are the only universal and important enemies of the coffee-tree. The destructions of *Arhines*, *Limacodes*, *Zeuzera*, *Phymatea*, *Strachia*, and the coffee-rat, appear to be of a more local and occasional nature, and are therefore of less importance. The rest of the species are nearly all enumerated for the sake of scientific completeness only. To the gentlemen, both here and in Europe, who have assisted me, I beg to tender my best thanks.

A few statistical notes will not be uninteresting to the reader abroad. The hill region of Ceylon covers an area of about 2000 square miles, is of a somewhat circular form, and its most elevated peaks rise to 8280 feet above the level of the sea. Systematic coffee planting is, from physiological reasons, ex-

clusively carried on in these hills, although irregular native garden-plantations are found everywhere in the island, even close to the sea-beach. The favourite elevation is between 1500 and 3500 feet, but in a few exceptional cases estates descend almost to the foot of the hills, whilst others are situated as high as 5500 feet and more. The number of systematically worked coffee estates, scattered all about these hills, amounts to about 420, divided amongst twenty-eight districts (very widely differing in some instances in physical aspect), covering an area of about 90,000 acres, producing about 600,000 cwts. of clean coffee (worth on the spot about £1,500,000 sterling), and giving employment to upwards of 100,000 persons, chiefly Tamil labourers from the coast of India. This is exclusive of about 50,000 acres of native coffee. It seems that the coffee-tree was brought to Ceylon by the Dutch, about two hundred years ago, but the first estate was only opened in 1825.

I now give a list of the names of the enemies of the coffee-tree and their parasites (in which I have not thought it necessary to adhere strictly to systematic order), and then proceed to detailed descriptions.

List of the Enemies of the Coffee-Tree and their Parasites.

HEMIPTERA.

1. *Pseudococcus Adonidum*, L? (White or mealy bug).
Parasites: *Scymnus rotundatus*, Motch. *Et. ent.* 1859; *Encyrtus Neitneri*, Motch. *loc. cit.*; *Chartocerus musciformis* Motch. *loc. cit.*; *Acarus translucens*, N.
2. *Lecanium coffeæ*, Walk. List. Ins. B. M. (Brown or scaly bug).
Parasites: *Scutellista cyanea*, Motch. *loc. cit.*; *Cephaleta purpureiventris*, Motch. *loc. cit.*; *C. brunneiventris*, Motch. *loc. cit.*; *C. fusciventris*, Motch. *in litt.*; *Encyrtus paradisiensis*, Motch. *in litt.*; *E. Neitneri*, Motch.; *Cirrhospilus coccivorus*, Motch. *in litt.*; *Marietta leopardina*, N. *in litt.*; *Chilocorus circumdatus*, Schonh.; *Acarus translucens*, N.
3. *Lecanium nigrum*, N. (Black bug).
4. *Syncladium Neitneri*, Rabb. Dresd. Hedwig. 1858. *Tripodoporum Gardneri*, Berk. J. Hort. Soc. Lond. 1849. A fungus.
5. *Aphis coffeæ* N. (Coffee-louse).
Parasites: *Syrphus Nietneri*, Schiner *in litt.*; *S. splendens*,

Dolesch.; *Micromus australis*, Hag. Verz. Wien. z.-b. G. 1858.

6. *Strachia geometrica*, Motch. in litt.

LEPIDOPTERA.

7. *Aloa lactinea*, Cram. pap. ex.
 8. *Orgyia ceylanica*, N.
 9. *Euproctis virguncula*, Walk. loc. cit.
 10. *Trichia exigua*, Field. in litt.
 11. *Narosa conspersa*, Walk. loc. cit.
 12. *Limacodes graciosa*, Westw. Ent. cab.
 13. *Drepana*?
 14. *Zeuzera coffea*, N.
 15. *Agrotis segetum*, Wien. V. (Black grub).
 16. *Galleriomorpha lichenoides*, Feld. in litt.
 17. *Boarmia ceylanicaria*, Feld. in litt.
 18. *B. leucostigmata*, Feld. in litt.
 19. *Eupithecia coffearia*, Feld. in litt.
 20. *Tortrix coffearia*, Feld. in litt.
 21. *Gracilaria*? *coffeifoliella*, Motch. loc. cit.

DIPTERA.

22. *Anthomyza*? *coffea*, N. in Motch. loc. cit.

ORTHOPTERA.

23. *Phymatea punctata*, D.

COLEOPTERA.

24. *Ancylonycha spec*? (White grub).
 25. *Arhines*? *destructor*, N.

APTERA.

26. *Acarus coffea*, N.

MAMMALIA.

27. *Golunda Elliotti*, Gray in Kel. Prod. (Coffee-rat).*

Descriptions and Observations.

1. *Pseudococcus Adonidum*, (White or mealy bug). *Male*: Head rather square, enlarged behind and rounded off at the posterior angles; eyes prominent, black; ocelli two, small, lateral; antennæ nine-jointed, second joint longest, third shortest, four to nine subequal; mouth externally represented by two black knobs resembling blunted mandibles. Thorax ample,

* The species marked Motch. in litt. and N. in litt. will probably be found described in Motch. Et. Ent. 1860; those marked Feld. in litt. and Schiner in litt. probably in Wien. Ent. Monatsch. 1860.



oblong-quadrate, enlarged at the shoulders; wings two, ample, two-nerved, hyaline, strongly iridescent, laid straight down the back, half overlapping each other when at rest. Scutellum ample, transverse, rounded at the apex. Abdomen sub-cylindrical, of shrivelled appearance, with two long anal setæ, which are slightly curled, and of mealy, brittle consistence. The insect is of light dirty-brownish colour and slightly hairy; it is very minute (very much smaller than the females, only about one-half line long), and resembles certain small Ephemeridæ or May-flies.

Female: Apterous, oval, brownish-purple, covered with a white mealy powder which forms a stiff fringe at the margin (one tooth or tuft to each segment on either side), and at the extremity of the abdomen two setæ. The back is laid out in three longitudinal and a number of transverse corrugations, the latter corresponding with the number of segments; upon each of the three longitudinal corrugations, the mealy secretion forms a sort of ridge-cap. The feelers, legs, and promuscis, are of light-brown colour and slightly hairy. The former are setaceous, eight-jointed (the last joint being the longest), nearly as long as the legs and porrected. The promuscis is situated between the anterior pair of legs, having a few hairs, but no sucking bristles at the tip.

The *larvæ* and *pupæ* of the female resemble the perfect insect, but are on a smaller and less perfect scale. In the male pupa wings and anal setæ are rudimental, in the male larvæ absent. These imperfect males rather resemble young Psoci or Aphides, but they carry the antennæ turned backwards, along the sides of the body. The larvæ and pupæ are active, move about.

The insects, in all stages of development, are found all the year round, the propagation being continuous. It appears to me, however, that the males are more plentiful about June and January than at any other season. They affect dry, hot localities, and are found as well on the branches as on the roots of the trees, to about one foot under ground. The eggs are actually laid and enveloped in a white cottony substance; they are oval and of yellow colour. I am not sure that there are not two species in the island, as I find some communities

rather flatter and more densely covered with meal. However, these may be local varieties. The white bug of the Ceylon coffee-tree seems to be identical with the species which is naturalised in the conservatories of Europe, and is perhaps a cosmopolite. It is closely allied to the *Pseudoc. cacti* of Linnaeus, the cochineal insect. There are several insects in the island resembling the white bug, but being of the size of a six-penny, and even shilling piece, these belong to the *G. Dorthesia*, and I have generally found the up-country species upon the stem of a laurel, *Tetranthera Gardneri*, Thw.

For general observations on the bug see farther on, after the description of the brown and black bug.

The white bug is preyed upon by the larva of *Scymnus rotundatus*. This is a minute beetle of the lady-bird tribe, as big as a pin's head, black and pubescent. The larva greatly resembles the white bug, and might easily be mistaken for it. It is, however, longer, narrower, flatter, and of a yellow colour, but covered thickly with stiff white hair of the same cottony substance as those of the bug. This covering is occasionally renewed, and is especially thick when the metamorphosis is at hand. This latter the larva undergoes in a thin oval cocoon, to which the white covering of the larva remains externally attached. This larva is very active, and attaches itself to the underside of the bug. I have reared several in March and April, 1859, in empty bottles. "Westwood, Introd.," vol. i. 398, mentions the larva of a *Scymnus* feeding upon Aphides, and, vol. ii. 443, feeding upon Aleurodes. The larva of the *Scymnus* is an external parasite, and M. de Motchulsky is wrong in stating that I had discovered it "*dans le Pseudoc.*"

The white bug is also preyed upon by the larvæ of *Encyrtus Neitneri* and *Chartocerus musciformis*, two minute Hymenoptera (wasps), the former of yellowish colour and common, the latter black and scarcer. They are only $\frac{1}{2}$ " long. There is also a very minute whitish-translucent mite which is found mixed up with the bug, and no doubt injures it to some extent. I will call it *Acarus translucens*.

2. *Lecanium coffeæ* (brown or scaly bug). *Male*: head transversely ovate-rotundate, narrowed, and square in front; eyes large, black; ocelli two, small, lateral; antennæ nine-

jointed, second joint smallest, third longest, thence decreasing to the tip; mouth as in the male of the white bug. Thorax ample, cordiform, narrowed in front; wings two, hyaline, two-nerved, subcostal nerve dark pink, not folded straight down the back when at rest, but half spread out. Scutellum as in white bug. Abdomen triangular; subcylindrical, of shrivelled appearance, with two lateral points, one central appendage, and two long, thin, white filaments at the extremity. The insect is still more delicate than the male *Pseudococcus*, of clear, light pinkish-brown colour, slightly hairy; very pretty.

Female: apterous, tortoise-like, yellowish, marbled with grey or light-brown, sub-oval, more or less semi-globose according to age; back with one elevated longitudinal, and two transverse costæ, uneven; split behind, at the extremity of a split bifid anal flab of brown colour; eyes marginal, black; antennæ seven-jointed, third joint longest; promusculis with one long sucking bristle. The old individuals are light brown with a dark margin, smooth, semi-globose, fixed to the branch.

Larvæ of female, with two anal filaments, which are lost in after-life. The larvæ and pupæ of both sexes are active, with the exception of the male pupa, which is plentiful on the underside of the leaves where the long, narrow, oval shell under which it rests is easily discovered. This shell is transparent, and composed of nine plates, three central and three on either side. I have occasionally found the entire underside of leaves covered with nothing but male pupæ, all dead. This species of bug affects elevated (above 3000 feet), cold, damp, close localities, where it is found in all stages of development all the year round, the propagation being, as in the white bug, continuous. As in the latter species, the males seem to be more abundant about June and January than at any other season. The eggs, which are oval and of pinkish colour, are not actually brought forth by the female; but when they are matured the parent insect dies, her whole interior forming one mass of eggs protected by the shell.

This kind of bug is closely allied to the lac-insect (*Coccus Lacca*, K.) of India.

The brown bug is much infested by parasites, amongst which the following are the most common: *Scutellista cyanea*,

Encyrtus Neitneri, *E. paradisicus*, *Cephaleta purpureiventris*, *C. brunneiventris*, *C. fusciventris*, *Cirrhospilus cocivorus*, *Marietta leopardina*. These are all Hymenoptera of the most minute description, presenting under the microscope the most elegant forms, and, for the most part, the most brilliant metallic colours. The *Marietta*, for instance, is spotted or ocellated all over black and white like a leopard. They can easily be obtained by putting a bugged branch, cut in convenient lengths, into a bottle, when after some time the little wasps will be found flying about inside, having made their escape from the bugs. The mother parasite lays her eggs amongst the bugs; when hatched, the young larvæ find their way easily to the soft underside of the bugs, where they attach themselves like leeches, and, protected and fed by the body of the bug, remain until they reach the perfect state. A bug thus attacked produces of course no eggs, and, instead of the young bugs, in course of time there escape those little wasps. The shells of the old bugs are frequently found with one or two holes; it is from these that the parasites have escaped. I have seen as many as six larvæ (belonging to different species of Hymenoptera) attached to one single bug. These larvæ can easily be seen on turning up some old bugs with the point of a penknife; they are little, white or yellowish, eyeless and footless maggots, some of which can leap to a considerable distance by doubling themselves up and spasmodically extending themselves again to their full length.

I shall revert to this subject again farther on.

On examining old full-grown bugs, the shells are often found filled, not with eggs, but with a white flaky substance, amongst which the above-mentioned mite, *Acarus translucens*, is seen busy. I have thought that the mite might have been the destroyer of the eggs in these cases, and that the flaky substance were the empty and decomposing egg-shells, but feel not certain on this subject. The planter has another friend in the larva of a kind of lady-bird which feeds upon the bug, viz., that of the *Chilocorus circumdatus* (syn. *Ch. nigro-marginatus*, N. in Motch. Et.) This larva is of ashy-grey colour, furnished with black spots and rows of black

spines. The perfect insect rather resembles a full-grown bug, being semi-globose, light brown, with black margin round the elytra. There is a variety which is altogether dark-brown. The larva skin splits, but is not thrown off when the insect assumes the pupa state. When the imago, or perfect insect, issues from its double shell, it is white, turns round (head towards tail of skins), and sits in this position upon its former envelopes for twenty-four hours before it moves off. During this time it gains its proper colouring. It is common at all seasons, but especially from March to September, and in all stages of the metamorphosis, the larva generally fixing itself to the underside of the leaf when its transformation approaches.

3. *Lecanium nigrum* (black bug).—The male of this species is unknown to me. The female is shield-like, much larger and flatter than the brown bug, colour from yellowish grey to deep brown and almost black, according to age; sub-oval, back with one longitudinal and two concentric oval costæ on disc, towards the margin slightly corrugated. The shell, seen through a microscope, is found to be composed of minute compartments, like the pavement of a street. Anal slit, and flab as in female brown bug. Old female shield-like, black, with slight longitudinal costa.

Larva, with two long, black anal setæ and projectile tube.

This species occurs alone and intermixed with the brown bug, but it is very distinct and at once recognised. It is much less abundant, and therefore of no importance to the planter. I have not succeeded in raising parasites from it.

In the natural course of my observations, I must now mention a fungus, viz.:—

4. *Syncladium Neitneri*, *Triposporium Gardneri*.—As soon as the bug has fairly established itself upon a coffee-tree, this latter begins to be covered with a fine black tissue, which upon examination proves to be a fungus of the above name. It comes and goes after the bug—never alone; first it has the appearance of a thin, diluted blackwash, but, rapidly increasing in density, within two or three months it quite covers and blackens the leaves and other parts of the tree, finally almost resembling moss. Its period of growth seems to extend over

about twelve months, when it is replaced by a young growth, or leaves the tree with the bug. When leaving the tree it peels off in large flakes. As the occupation of a coffee or any other tree gives rise to the appearance of a glutinous, saccharine substance—honey-dew (either a secretion of the bug or the extravasated sap which flows from the wounded tree, but more probably a combination of both)—which disappears with the bug, and as the fungus does exactly the same, I have no doubt that its vegetation depends upon the honey-dew. There appears to be some doubt whether there are one or two species of this fungus upon the coffee-tree. The late Dr Gardener sent a specimen to the Rev. Mr Berkeley, the eminent English cryptogamist, who described it as *T. Gardneri*. I sent two years ago, specimens both to Mr Berkeley and Dr Rabenhorst of Dresden, when the latter named it *S. Neitneri*, informing me, upon inquiry, that it was quite different from the *Triposporium*, having *simple sporæ*, whilst those of the latter are *composite*. Mr Berkeley said that he was not certain whether the specimen I sent him was in a different state or a different genus from his *Triposporium*. Remembering the extraordinary changes plants of such simple organism as the one under consideration undergo in the course of their development, I should feel inclined to think that *Syncladium* and *Triposporium* are one and the same, but am unable to finally decide on this point, which, moreover, is of little consequence. Of more interest is it that Dr Rabenhorst received the identical fungus, at the same time, from me and from a correspondent in Nizza (Nice), where it covers the leaves of the olive-tree in the same manner as it does the coffee-tree here. It would be curious to know whether its development there depends upon honey-dew, as, to all appearances, it does here.

I now add some general observations on the coffee-bug.

Most planters with whom I have conversed on the subject, not being entomologists, appeared to look upon the coffee-bug as something most unaccountable, almost mysterious, entertaining very erroneous and extraordinary ideas regarding it. The fact is that there is nothing whatever unusual or extraordinary about it, excepting the apparent capriciousness with

which it comes and goes: now rapidly spreading over a whole estate, now confining itself to a single tree amongst thousands; here leaving an estate in the course of a twelvemonth, there remaining for ever; and so forth. The members of this family of insects (Coccidæ), to say nothing of the entire order (Homoptera), are in many instances of very great economical importance. I have already mentioned the cochineal and lac insects as amongst the most prominent in this respect; but whilst these are useful, there are, on the other hand, others which are an excessive nuisance to the gardener and agriculturist. Foremost amongst these ranks, undoubtedly, the coffee-bug; and the *blight* of the sugar-cane in the Mauritius also belongs to this family (*Aspidiotus*?). In an entomological point of view, these insects are interesting from other reasons. The habits of the Coccidæ have, consequently, long since been the object of study with entomologists. Westwood (*Introd.* 1840) in his bibliographical reference of the Coccidæ, mentions not less than between thirty and forty authors who have written on this subject. In fact, every general entomologist, from Linnæus downwards, has noticed them. The study was facilitated by the circumstance that there are many species indigenous to Europe.

Although, as above stated, the coffee-tree has been known in Ceylon for about two hundred years, and although systematically worked estates have existed since 1825, the bug does not appear to have attracted attention, that is to say, not to have appeared in large quantities, till about 1845, when, however, it began to spread with such rapidity that, in 1847, a very general alarm was taken by the planters. It will be remembered that about the same time the potato, vine, and olive disease began to become very alarming in Europe. With reference to this comparatively recent appearance of the bug in the island, it has been suggested, that it was not indigenous, but had been introduced with seed coffee from some other country. However, the grounds for this assertion are insufficient, and I consider it as indigenous, seeing that it is found upon many other plants besides coffee: I have seen the white bug upon orange, guava, and other trees, also upon vegetables, beet-roots, &c. The brown bug is still less particular, and

attacks almost every plant and tree that grows on a coffee estate, more particularly, though, such as are grown in gardens: guavas, hibiscus, ixoras, justicias, oranges—everything, even weeds. It has also been said that the brown bug came originally from the wild guava (*Psidium pyriferum*) upon the coffee; but this seems to me improbable, because I have never seen the guava bugged in its *wild* state, and I have had very good opportunity for observation. It is, however, not to be denied that the bug gives it a decided preference, when it grows with other trees on a coffee estate. I have already alluded to the *capriciousness* of the bug: why, as is its wont, instead of spreading itself evenly over an estate, as one would expect it to do, it should attack a certain field only, then after a while leave that and go to another, and then to another, and another, it would not be easy to explain satisfactorily. All that is certain is, as I have already mentioned, that the white bug prefers dry, and the brown bug damp localities; and this is to be observed more in detail on any individual estate. The brown bug will be found more plentiful in close ravines, and amongst heavy rotting timber, than on open hillsides. The shifting from place to place depends, probably, upon this predilection of the insect. The bug, of course, seeks out the softest and most sheltered parts of the tree: the young shoots, the underside of the leaves, and the clusters of berries. The injury done by the white species seems worse than that of the brown, but not being so plentiful as the latter, it is of less general importance. The white bug is especially fond of congregating amongst the clusters of berries, which drop off from the injury they receive: trees often lose their entire crop in this manner. The injury of the brown bug seems to have a more general effect, by simply weakening the tree; but the crop does not drop off altogether, nor so suddenly. With white bug on the estate the crop can hardly be estimated; with brown bug it can.

With regard to the nature of the injury a tree receives from the bug, it may be said that a tree thus attacked suffers from *loss of blood (sap)*, and from *partial starvation and suffocation*. In this manner, the bug, by means of its sucker, deprives the tree of its sap, that is its blood and nourishment, after it has entered

the organism ; whilst the fungus, which never fails to attend upon the bug, with its rootlets and otherwise, closes a vast number of the stomates through which the tree breathes and perspires, thus impeding its respiration. It is, moreover, probable that a tree covered with fungus, being, as it were, placed in the shade, the due decomposition of the carbonic acid of the atmosphere is prevented in such cases, and that the rootlets of the fungus act in a manner very similar to the sucker of the bug. It is not to be wondered, then, that a tree covered all over with bug and fungus should get exhausted. Bug exists on the estates to an incalculable extent ; none, I believe, are quite free from it. A thoroughly bugged tree will hardly produce any crop at all. Whole estates are seen " black with bug," that is, with the fungus. Am I wrong in saying that if there was no bug in Ceylon it would, at a rough guess, produce 50,000 cwts. more coffee than it actually does ? The value of this quantity on the spot being about L.125,000, this sum would represent the aggregate of the annual loss by bug sustained by the planters. But this is not all : the value of an estate on which bug appears to be chronic is, of course, much less, yielding less crop than that of a clean one.

I have been asked how the bug came to an estate ? The eggs, which are a mere dust, are carried about by birds or insects to whom they adhere, or by the wind. If these are deposited in a favourable place they will hatch, and we have then the bug in the larva state. The larvæ in course of time assume a more perfect form, the pupa state, and eventually change into the imago or perfect insect. In the larva state the male and female brown bug are not distinguishable ; but in the pupa state the male is very distinct, having all the characteristics of the perfect insect about it. In the white bug the male and female larvæ and pupæ are always distinct. The perfect males either do not feed at all, or if they do, it is probably upon honey-dew, for having no sucker they cannot feed like the females. The number of eggs produced by a female brown bug is about 700. Those of the white bug are not so numerous. The species of bugs indigenous to cold climates produce but one generation of young annually ; the propagation in our species being *continuous*, accounts, in a great measure,

for their abundance here. The males are so delicate and minute that they will hardly ever be observed on the trees, but they are easily reared in bottles.

The brown bug is dreadfully infested with parasites, especially the larvæ of minute Hymenoptera. The individuals attacked are generally full-grown females, probably because they are the most juicy. The parasites are very numerous: not only have I found as many as six preying upon a single bug, but I have actually had difficulty in finding a sound old female for examination, and (upon counting) repeatedly found that from 50 to 75 per cent. were infested with parasites. If it be remembered that each of these would have produced some 700 young, it becomes at once clear that the parasites are of enormous benefit to the planter. Indeed, it is a question whether coffee-planting could be carried on without them; for these parasites, the females of which, by a benevolent design of nature, greatly preponderate over the males, are almost the only check upon the bug we have, no human ingenuity having hitherto devised a remedy that could be *profitably* employed either as a preventative or a cure. Numerous, indeed, are the suggestions which have been made on this point, but none have succeeded. The remedies resorted to at home by gardeners to destroy bug in conservatories or upon fruit-trees cannot be thought of here upon 90,000 acres of coffee, each acre containing from 1200 to 1600 trees. Some six years ago it was suggested to introduce the large red tree-ant of the low country (*Formica smaragdina*, Fab.)* on the coffee-estates, in the hope that it would destroy the bug. The suggester did not understand the relations actually existing between bugs and ants; besides, the remedy was worse than the evil, these ants being so fierce, and their bite so painful, that the coolies would not go amongst the trees as long as they were there. Our bugged coffee-trees are visited by other species of ants commonly enough, but they do not drive away the bug: by means of tickling or caressing with the feelers, they induce it to emit a certain saccharine fluid which it secretes,

* The specific name applies to the female, which is large and green; the male is small and black; the red individuals usually found in the nests (and of which there are several sizes) are the neuters.

and this the ants eagerly eat, but they do not eat the bug itself. The latter act of ungratefulness may, and does, occasionally take place, but they do not seek the bug for this purpose. It is an old remark of Linnæus, that the Coccidæ and Aphides are the milch-cows of the ants. Quite recently I found under the bark of a dead jungle-tree a colony of ants and white bug, the latter being, to all appearances, kept and fed by the former; and I can testify to the excellent condition the bugs were in. It may be said that the bugs might be otherwise injured by the visits of the ants, and die out, but there is not sufficient evidence for this assertion.

Rubbing off the bug by hand has been tried, but it can only be attempted upon young trees without crop. The quantity of bug destroyed by this simple means is certainly immense, but I am afraid that upon the whole the effect is but trifling.

The application of tar to the roots has been suggested, it being said that, taken up into the system of the tree, it throws off the bug. Although hitherto no important results have been achieved by carrying it out, this idea strikes me as a *very valuable one*: *it is through the root of the tree the evil should be dealt with*; but a substitute for tar should be sought for, more powerful, and more deadly to the bug, but at the same time equally harmless to the tree.

But generally, nothing at all is attempted to get rid of the bug, and under existing circumstances it is perhaps as well. High cultivation seems to have the effect of throwing it off also, and would be a very desirable cure if it could be carried out universally.—And suppose an estate did get rid of the bug, would it not soon make its appearance again from a neighbouring plantation? As the bug seems to depend upon *locality*—as long as the physical aspect of that is not changed, what can be expected? unless it were by some cheap means destroyed simultaneously on all estates. I should think that if pattenas, which are open, warm, airy localities, were cultivated (which they can be, as experiments on a large scale tried at Fusselaw show), the brown bug, which is, after all, the bug *par excellence*, would not find them so favourable to its existence as the localities in which at present it thrives best; but again the white bug might find them very suitable places.

Or, perhaps, if estates, as a rule, were made smaller than they generally are, and if the reduction in acreage were counter-balanced by a higher system of cultivation, *universally* carried out, bug would not be so plentiful as it is now.

I regret that I have nothing of more importance to say on this interesting subject.

It has been mentioned to me that the bug was subject to a disease—a white covering forming over and destroying it. This is simply mould. I do not believe that it ever attacks live individuals; but at very wet times and in very close places it may cover the old fixed females: the active part of the community would, one should think, move off. The black fungus also overruns old females or their empty shells.

Westwood, "Introd.," vol. ii. 445, 446, says that the ocelli are wanting, and the mouth is completely obsolete in the male Coccidæ; also that the male pupa is inactive, and covered with a pellicle. From the descriptions given above, it will be seen that my observations differ from these statements: the male pupa of *L. coffeæ* is as described by Westwood, but that of the *P. adonidum* is active. Ocelli and mouth are both very distinct in either species. I have not succeeded in catching a male brown bug in the act of emerging from its shell, although I much wished to ascertain whether it was done in the curious manner mentioned by Westwood.

With this I shall dismiss the coffee-bug, trusting that I have not dwelt too long upon it already.

5. *Aphis coffeæ* (Coffee-louse).—*Both sexes*: naked, shiny pitch black, with whitish rostrum, antennæ and legs, and greenish abdomen. The rostrum reaches to beyond the base of the second pair of legs. The antennæ are seven-jointed, the first, second, and sixth being short, the rest long; the two basal joints are black, the rest whitish, black towards apex. Legs with femora and tarsi nearly black, tibiæ nearly white, hind legs with base of tibiæ slightly curved. Male four-winged, with black stigma in the upper ones. Female apterous. Abdomen in both sexes two-corniculate, and with an anal tube. Size middling. Young individuals light coloured.

The insect just described is found in larger or smaller communities upon the young shoots and on the underside of

the leaves of the coffee-tree. Its presence in large numbers produces honey-dew and syncladium, as in the case of the bug. The procreative power of this family of insects (Aphidæ) is well-known, and unequalled in nature: from *one impregnation* nine fruitful generations of females have been produced in three months; in another instance eleven generations in seven months; in a third instance they continued to propagate for four years! (Westwood.) The eggs being hatched in the body of the mother-insect, the young come forth alive. Such productiveness, however, does not appear to exist amongst the *A. coffeæ*; at all events the communities are generally small, and their injuries of no consequence. But a species which feeds upon the orange and citron-tree is much more productive. From the anal tubercles a saccharine fluid is discharged of which the ants are very fond, as in the instance of the Coccidæ.

The *A. coffeæ* is subject to the attacks of various parasites: *Syrphus Neitneri*, *S. splendens*. These are two large flies belonging to the family, the members of which, from their resemblance to bees and wasps, might be called "bee-flies." They rather resemble each other, are of dingy colours, black, abdomen variegated with whitish-yellow bands; the former is pubescent, the latter smooth; they are both $\frac{3}{8}$ " long and $\frac{3}{8}$ " across the expanded wings. Their larvæ devour the Aphides: these are soft, unsightly, eyeless and footless worms, narrowed on one end, $\frac{1}{4}$ " long when full grown. That of the *Syrphus Neitneri* is brown, with a lighter dorsal mark; the segments are drawn out into scale-like knobs, which form a ridge along the centre of the back. That of the *Syrphus splendens* is green, with a whitish dorsal mark. They make immense havoc amongst the Aphides, being so voracious that in twenty-four hours they increase double their volume. The pupa is pear-shaped, resting within the larva skin for eight days, when the perfect insect comes forth.

Another enemy is *Micromus australis*. This is a pretty little insect allied to the tribe of the ant-lions. Feeding upon plant-lice, the larvæ have been called "Aphis lions," but from their shape they might more appropriately be styled "Aphis Crocodiles." This larva is about $\frac{5}{8}$ " long, narrow, depressed,

tapering towards both ends, lightly covered with white hair. It is of brownish colour, sides, dorsal line, and under-sides white. It is very active and voracious, and has a pair of enormous sickle-shaped jaws, and long slender palpi and feelers. The former are distinctly three-jointed, the last joint being very long, and the whole palpi as long as the mandibles. Between head and throat there is a distinct neck. The larva encloses itself in a light cocoon, in which the pupa rests for two weeks, when the perfect insect makes its appearance. This latter is very delicate, brownish, with green eyes. The eggs of these insects are deposited upon leaves, each egg being furnished with a long thin peduncle, thus resembling pins or certain fungi.

There are several minute Hymenoptera parasitic upon the *Aphis coffeæ*, but I am unable to give their names.

6. *Strachia geometrica*.—This is a bug, but of a different description from the brown and white bug, to which it bears but little resemblance. It is oblong-oval, argulated, plump, $\frac{1}{8}$ " long by $\frac{1}{8}$ " wide, of yellowish colour, marbled on the upper-side, with grey and orange. It is allied to the so-called green or foetid bug.

Mr Alexander Brown received this insect from Badulla and kindly forwarded it to me. It feeds upon the juice of the young berries, three per cent. or more of which were said to have been damaged from this cause. This is the only instance of coffee suffering from this insect that has come under my notice. However, allied forms are found both here and in Europe, doing sometimes considerable damage to vegetables by destroying the buds. There is no fear of the insect ever becoming a *serious* nuisance on coffee plantations.

I now come to the enemies of the coffee-tree belonging to the order of the Lepidoptera, the larvæ of which, being entirely dependent upon the vegetable kingdom for their sustenance, do more or less injury to the horticulturists and agriculturists of every country. Fortunately, although I shall mention fifteen different kinds (a number that might easily be doubled) that feed upon the coffee-tree, there are but two or three which do any serious injury.

7. *Aloa lactinea*.—Caterpillar about 2" long, black, thickly

covered with long brown hair, resembling the so-called "woolly bear," or caterpillar of the *Arctia caja* at home. It is found during the dry weather, weaves an underground cocoon of earth and hair in which the chrysalis rests for two months, when the moth comes forth in July or August. This latter is 1" long and $2\frac{1}{4}$ " across the expanded wings, of pure white, edged with red, and a few black marks on the wings; the back of the abdomen is yellow, variegated with black. It is also found upon the Eastern Islands; here it is by no means common.

8. *Orgyia ceylanica*.—Caterpillar $1\frac{1}{2}$ " long, brown, under-side and head reddish, covered with yellowish hair, two long slender tufts of dark hair on either side of the head like horns, and another behind like a tail, four short, stiff, white tufts upon the anterior part of the back, and two similar ones on either side. Not uncommon from October to December; spins a thin cocoon, in which the chrysalis rests for two weeks. The female moth is an ugly, sluggish, maggot-like insect, with rudimental, whitish, scale-like wings; it is of dirty, yellowish colour, covered with fine black hair, rather thickly towards the extremity of the abdomen and the sides. It is $\frac{3}{8}$ " long. The male, on the contrary, is a lively little fellow, $\frac{3}{4}$ " across the wings, brown, variegated with a little black and white, rather common during the beginning of the hot weather.

9. *Euproctis virgencula*.—Caterpillar hairy, black, variegated with red spots, $\frac{3}{4}$ " long; from February to May spins a light cocoon, in which the chrysalis rests for two weeks. Moth $1\frac{3}{4}$ " across the wings, of pure white colour, with black eyes, back of abdomen slashed with black, large yellow tuft at the extremity. During the dry weather rather common upon the pattenas, which alternate with the plantations.

10. *Trichia exigua*.—Caterpillar from September to December, $\frac{1}{2}$ " to $\frac{3}{4}$ " long, brown above, grey below, variegated with red and yellow lines and dots, hairy, each segment with two short tufts, behind head two fleshy earlike protuberances, a haunch upon forepart of back. It spins a light cocoon, from which, after two weeks, the moth escapes. This is 1" across the wings, the upper ones of which are yellowish grey, with

some yellow spots, the lower ones yellowish. It is not common. The caterpillar is also found upon orange and other trees.

11. *Narosa conspersa*.—Caterpillar $\frac{3}{4}$ " long and $\frac{3}{8}$ " wide, oval, onisciform, transversely corrugated (2) longitudinal dorsal costæ, margin flat, legs retractile, yellow. From August to November encloses itself (often in a single night) in an entire, strong, small, oval, cartilaginous, white cocoon, with a circular brown spot on one end, which is commonly seen affixed to the coffee leaves. The moth, which is rather common during the dry weather, is very pretty, and often flies into rooms at night. It measures $1\frac{1}{4}$ " across the wings, the upper ones of which are marked like a tiger, yellow and brown, the lower ones being yellow. The caterpillar keeps to the under-side of the leaves, and is not often seen. It feeds at night.

12. *Limacodes graciosa*.—Caterpillar from June to August, 1" long and 3" broad, more so in front, less behind; back of opal-whitish colour, sides greenish, the former with three broad, green, longitudinal stripes edged with darker green, four rows of glands covered with spines, four of which in front and two behind are tipped with brown, four lateral black spots near anus. Head brown, retractile. Ventral and anal feet abortive. Encloses itself under a thin tissue, in a strong, oval cocoon, or rather half-cocoon, the lower side being formed by the material to which it is affixed. The ohrysalis rests from the middle of August to the middle of October; it is short, plump, oval, and its skin slightly drawn out of the cocoon when the moth escapes. This latter is strikingly pretty, $1\frac{1}{2}$ " across the wings, of fine green colour above, middle of thorax, shoulders, and broad margin behind, rich chocolate brown, lower wings light grey-brown, rest of body dark brown. Westwood (*Cab. Or. Ent.*) is not correct in what he says about the male; this latter is like the female, but smaller, 1" across the wings, the antennæ are two, pectinated from the base to the middle, whilst they are simple in the female. Both sexes have two green spots on the lower side of the thorax, which Westwood does not mention. Mr Evatt, who kindly sent me the caterpillars of this insect from Ambanpittia, writes that they are very active in destroying the leaves of the coffee-trees in that part of the country; that they

disappear sometimes, but invariably return, and prefer fine young coffee in sheltered places. I have also heard of them from Ambegamoa.

13. *Drepana*.—I only mention this scarce insect on account of its curious caterpillar, which is occasionally met with upon coffee. This is about 2" long, and as thick as a moderate goose quill, naked, occiput conical, a horn upon the anterior part of the back, anal feet wanting, body abruptly semi-truncated behind, but drawn out into a tail of considerable length. It is of brownish-purple colour, variegated with lighter patches on the sides in front, and grey rings on the tail. It resembles the caterpillar of the puss and kitten moth of England. The moth, of which I have no exact description (all my specimens having been lost in the Alma) is, if I remember rightly, about $1\frac{1}{2}$ " across, dark bluish-grey above, and brownish below.

14. *Zeuzera coffea*.—This insect is of more importance to the planter, as it destroys many trees, young and old, the caterpillar eating out the heart; for this purpose it generally enters the tree 6" or 12" from the ground, ascending upwards. Fortunately it is not abundant. It resembles the caterpillar of the goat-moth of England, is 2" long, and as thick as a goose quill, nearly naked, of yellowish colour, back red, head thoracic, and anal plates blackish; when full grown the colours are light and dirty. The sickly drooping foliage, and a heap of globules of conglomerated wood dust at the foot of a tree, soon indicate that the caterpillar is carrying on its destructive work inside. The chrysalis rests three months, and its skin half protrudes from the hole when the moth escapes, which is about February. The moth measures $1\frac{3}{4}$ " across the wings, which are white, spotted with steel-blue, the upper ones with one large spot and numerous series of small ones, placed in rows between the nerves; the lower wings are less spotted. Thorax with four spots near margin. Abdomen variegated with blue. Legs blue, second pair with white femora, third pair with white femora and tibiae.

15. *Agrotis segetum* (Black Grub).—The larva of this moth is the well-known and very destructive "black grub." It is 1" long, and as thick as a goose quill, blackish, with black head

and lateral dots, nearly naked. It is most abundant from August to October. The chrysalis rests four weeks in the ground, and the moth comes forth in November and December. The latter is $1\frac{1}{4}$ " across the wings, of clouded, dark grey-brown colour above, with whitish posterior margin to upper wings; lower wings, abdomen, and legs, whitish-grey. The caterpillar is very common and injurious, whereas the moth is scarce. The former lives in the ground, but comes forth at night to feed. It attacks not only coffee-trees, but all sorts of vegetables and flowers, being consequently a great nuisance in gardens as well as in the field. I believe they eat everything that is artificially raised, despising grass and weeds. I have lost many valuable seedlings in my garden through them, and have seen as many as six of them engaged upon one endive plant. On a neighbouring plantation they effectually put a stop to the cultivation of potatoes. It only attacks young coffee-trees, gnawing off the bark round the stem just above the ground. Should the trees be very small, they are bitten right off, and the tips sometimes partially dragged under the ground, whence the grubs may easily be dislodged. The damage they thus do to young plantations is often very considerable. I lost myself, in one season, in certain fields, as many as twenty-five per cent. of the young trees I had put out, through them. They generally appear only in certain fields, not all over the estate. A little lime put into the ground with the young plants is said to keep them off, which I can easily believe; but one would think that the ashes of the recently burned forest would be sufficient to do so.

The insect is by no means confined to Ceylon, its ravages being well known in India, at the Cape of Good Hope, and in Europe; probably it occurs in many other countries. Its name, *A. segetum*, indicates the nature of its ravages in Europe—it injures the grain crops, but there, as here, almost any agricultural produce is welcome to it. I saw a notice in a recently published paper of its destruction of the beet-root, which is very extensively cultivated on the continent of Europe.

16. *Galleriomorpha lichenoides*.—This is a little moth $\frac{5}{8}$ " across the wings, of marbled dark greyish brown colour forward,

lighter behind, which is occasionally found upon coffee, where its larva feeds.

17. *Boarmia leucostigmata*.

18. *Boarmia ceylanicaria*.

19. *Eupithecia coffearia*.

These are three insects belonging to that family of moths, the caterpillars of which, from their way of moving (like leeches), are called loopers or geometricians. The caterpillars, which are about $1\frac{1}{4}$ " long, and rather thinner than a goose quill, are evidently meant by nature to resemble, for their security, small twigs, and this they do to a very great degree. The colour of that of the *B. ceylanicaria* is, when young, dark, when older, light grey, marked with dark patches and stripes along the sides, and there is a swelling about the neck and the tail. When at rest they stand straight on end (as leeches also sometimes do), and resemble twigs very closely. The moths, which are of delicate and slender make, are found sitting with expanded wings on trees or the walls of houses. They are found from September to December, but are anything but abundant. The coffee-tree is not the only one upon which the caterpillars feed.

The *B. leucostigmata* is rather a handsome moth, both pairs of wings being greyish-white, beautifully fringed, and marked with dark lines and red pencilling; below both are marked with a large black stripe. It measures nearly 2" across the expanded wings; and the antennæ of the male are slightly two-pectinated to within one-fourth of the tip.

The *B. ceylanicaria* is smaller, yellowish-grey, marbled with brown. The *Eupithecia* is still smaller and still darker.

20. *Tortrix coffearia*.—The larva is $\frac{3}{4}$ " long, $1\frac{1}{2}$ " thick, nearly naked, greenish, head and thoracic plate brown. It is found nearly all the year round, not exclusively upon coffee, but also upon a variety of garden plants, the leaves of which it draws together, residing inside. The moth is 1" across, shaped like a perpendicular section of a bell, light brown, clouded more or less with a darker tint of the same colour. It is not at all common.

21. *Gracilaria coffeifoliella*.—This is a moth of the most minute description, measuring but 1" in length, and 2" across

the expanded wings; it is of blackish colour above, with a few silvery spots, and greyish below. Its larva mines the coffee leaves, and the ugly white lines and blotches so frequently and at all seasons seen upon the leaves are its work. It gets under the epidermis, and eats out the inner parts of the leaf. The larva is $2\frac{1}{4}$ " long, yellow, flat, naked, undulated at the sides, tapering towards either extremity, eyeless and footless. The body consists of fourteen segments including the head; this latter is brown, pointed at the extremity, and one half retractile; it is furnished near the extremity with two antennal appendages, each with three hairs at the tip; the jaws are large and quite free at the extremity of the head, mooring between two large reniform lips, which gives the head a curious appearance. The penultimate segment is the smallest of all, and furnished with two spurs pointing outwards. The chrysalis is $1\frac{3}{4}$ " long, blackish in the middle, and yellow at the extremities; the head finishes in one, and the tail in two spines; antennæ and feet are free at the extremity. It rests for a short time under the epidermis of the leaf in a sort of cradle. The insect is very common, but of no importance to the planter. Far different is it with an allied species, the *Elachista coffeella*, G. M., the larva of which is the greatest enemy of the coffee-tree in the West Indies. This latter is of silvery white colour.

22. *Anthomyza? coffeæ*.*—This is an inconspicuous grey fly, measuring hardly $1\frac{1}{2}$ " across the wings, the larva of which mines the coffee leaves in the same manner as that of the preceding species, but much less extensively. It is found more particularly during the dry weather, but is not numerous. The larva undergoes its transformation in a minute, flat, oval cocoon (resembling a seed) under the epidermis of the leaf.

23. *Phymatea punctata*.—This is the large, well-known, beautiful locust with the scarlet abdomen, yellow and bronze above, which seems to attack all agricultural produce that comes in its way. It does not habitually attack the coffee-tree,

* Not *A. coffeifolia* as printed in Motch. *Et. Ent.* Nor is the larva parasitic upon that of the *Gracilaria*, as M. de Motch. suggests, never being found in the same burrows, but generally upon separate leaves. Perhaps belonging to *Agromyza*.



but does so occasionally ; and I speak from experience when I state that its ravages are very annoying. A swarm of them settled upon a field of one year old coffee, and gnawed the bark off the stems. The consequence was that the growth of the tree was checked in the upper part, and that a multitude of unsightly shoots were thrown out by the lower ; eventually the top broke off, or was cut off, and the tree remained disfigured for the rest of its existence. There were at least fifteen per cent. of the trees thus injured. I remember seeing a coco-nut plantation at Negombo infested with these locusts, the enormous leaves of the trees bending under their weight and presenting mere skeletons—everything but the ribs having been devoured. A great many of the locusts had dropped off upon the Illook-grass (*Sachch. Koenigii*, Retz.) which grew beneath, but they would not touch this,—in fact, I have never seen them eat any but cultivated plants or trees. At Tangalle I have known them to destroy tobacco plantations ; and a couple of years ago, I was addressed by the Government agent, Kandy, with reference to the destruction the grain crops of the natives in Matelle were then suffering from these locusts. Fortunately this seems the only species of locust that does any real injury in Ceylon, and this injury is in importance not to be compared with that done by other species in other countries. (See “Kirby and Spence’s *Introd. to Ent.*” for details on this subject.) The larvæ and pupæ are equally destructive as the perfect insects.

24. *Ancylonycha spec?* (White Grub).—Under the name of “white grub” the larvæ of various Melolonthidæ do much harm to coffee-plantations, young and old, by eating the roots of the trees. These insects are the cockchafer of this country, and their injuries are of the same nature as those of their representatives at home. Mr J. L. Gordon, of Rambodde, kindly sent me a bottle full of these grubs, for examination. They were $1\frac{1}{2}$ inch long and $\frac{1}{2}$ inch thick, whitish, thinly covered with red hair, mandibles strong, legs four-jointed, second and third joint soldered together, antennæ five-jointed. As the larvæ of the cockchafer family remain for years in that imperfect state, it is difficult to rear them. I took the larvæ sent

* Probably *A. Reynaudii*, Blanch ; perhaps *A. mucida*, Schæn.

me for that of a species of *Ancylonycha*, which, in its perfect state, is very common about coffee estates during the dry weather; but there are undoubtedly other species, the larvæ of which feed with that of the *Ancylonycha*. Mr Gordon mentioned that he sometimes found larvæ three times as big as those he sent me. These belonged in all probability to the *Leucopholis pinguis*, the large cockchafer, which flies about the pattenas on fine evenings during the dry weather. But I feel certain that cases in which it feeds upon coffee-roots are exceptional, as I have very commonly seen it emerge from the ground on the pattenas; from which circumstance I conclude that it generally feeds upon the roots of the pattenas grasses (*Andropogon*, *Anthistiria*, &c.) There are many representatives, large and small, of the cockchafer family in this country, but they appear to do no damage in the perfect state.

With regard to the ravages of the white grub, Mr Gordon writes: "They are in my experience by far the greatest enemy of the coffee-tree we have to contend against, as I never knew a single tree to recover after their attack. The damage done here, during the last two years, has been very great—between eight and ten thousand trees of fine old coffee have been destroyed." Fortunately such extensive injuries are exceptional cases. Mr Gordon used to dig up the soil at the foot of the trees, and take out such grubs as he could find.

25. *Arhines? destructor*.—This is a beautiful green weevil; $2\frac{1}{2}$ " long and 1" broad, oval, narrowed in front, covered all over with closely set but isolated gold green scales, winged. The head is rather short and blunt; antennæ apical, elbowed at the middle, the part beyond the middle being composed of eleven joints, forming a club towards the end, the third joint from the tip being the thickest; they are brown, hairy beyond the middle; the thorax is plump, subconical; the anterior legs are the longest, the second pair the shortest, the tibiæ and tarsi of all are hairy, the tarsi with hairy brushes underneath, especially thick at the third joint which is deeply two-lobed; the tibiæ of the second pair are long, serrated inside, curved, and two-hooked at the apex. The insect varies considerably in size and colour.

This pretty beetle is common during the dry weather, but I

have never found it do any injury to the coffee. Mr James Rose, of Maturatte, who first directed my attention to it, writes to me: "The mischief they do to the coffee is really frightful, and if they were as plentiful as the bug, they would be our worst enemies. Five or six acres were completely covered with them, and they consumed almost every leaf. Year after year they appeared upon the same place. This year they appeared upon a neighbouring estate in great force, and ran over at least forty acres. The same thing occurred on three other estates." Mr Rose conveys a pretty picture to the mind of the entomologist by stating, that in May, when these insects disappear, the logs and rocks may be seen strewn with their bright green elytra.

The family of the weevils is one of the most extensive amongst the beetles, and many of its members, both here and in Europe, do much injury to agricultural produce. I have seen nearly the whole sweet potato (*Batatas edulis*) crop of the Negombo district destroyed by one of them, the *Cylas turcipennis*. The common rice-weevil, *Sitophilus oryzae*, is another instance; and one of the coco-nut destroyers of the low country belongs also to this family, the *Sphaenophorus planipennis*.

26. *Acarus coffea*.—This is a very minute mite, hardly perceptible to the naked eye, which feeds upon the coffee-leaves nearly all the year round, but more commonly from November to April, giving them a brownish sun-burnt appearance. The damage it does is not great in the aggregate, but individual trees certainly suffer from it. It is closely allied to the "red spider" of the hot-houses in Europe—oval, naked, light red, abdomen darker, four rows of hair along the back, legs hairy. It feeds on the upper side of the leaves, where, amongst the live insects, empty skins and minute red globules are found in plenty. These globules are fixed by a style to the leaf, and are the young in the first stage of existence. The style is the mouth, but the rest of the body is a perfect globule without any appendages whatever. These latter, however, gradually break forth; and when the animalcule is furnished with all it requires, it lets go its hold.

27. *Golunda Elliotti* (Coffee-Rat).—This well-known animal

does not habitually reside on coffee-estates, but comes apparently, when its food fails, from the jungle to the neighbouring estates to supply its wants there. Hence estates with much surrounding jungle are more liable to be infested than others, in the same way as the fields adjoining the jungle suffer more than the more remote ones.

There is a plant which forms a common underwood from six to twelve feet high in the upper jungle—the “Nilloo” of the natives (a species of *Strobilanthus*)—of which it is said that it blossoms every seven years and then dies, whereby the rats are deprived of their accustomed food, and induced or compelled to issue forth on to the estates. This is a popular story, but it is not clear to me, and I have no confidence in it. That the Nilloo blossoms and dies off every seven years, and that the rats feed upon some part of it, I will not dispute. But the Nilloo is not all of the same age, and consequently some will die every year. Besides, the story of the rats coming every seven years is not at all borne out by my experience. We had them here in 1858 and in 1860, and again in 1861. However, when they do come, they are sometimes in very great numbers, and their devastations are very serious. With their long sharp incisors they bite off the smaller and younger branches of the trees, beautifully, regularly, and smooth, and generally 1" or so from the stem, so as to allow them to rest upon the stump whilst they are gnawing it through. Should the plants be quite young, just taken from the nursery, they bite them right off a few inches from the ground. Their object in doing this is, no doubt, first to get, like other rodentia, at the bark, which they do not appear to devour entirely, but simply to masticate for the sake of the juice,—but probably they act in this respect in accordance with the state of their appetite; and, secondly, to get the leaves for their nests. These latter are commonly found in hollow trees, whither they also drag the bitten-off branches. They seldom appear to eat the berries. They are destroyed either by poison or by traps, in which latter enormous numbers are said to have been caught. There is hardly an estate that does not now and then receive a visit from them.

A small squirrel (probably the *Sciurus Layardi*, Blyth) is

commonly found about coffee-estates. This does what the rat apparently does not—eat the berries, which being indigestible, with the exception of the outside pulp, are afterwards dropped and found upon logs and on the ground, in the shape of parchment coffee. Jackals and monkeys occasionally do the same, and a deer will now and then come from the forest and nibble the tops of the young trees ; but these are not serious injuries. By far more so are those arising from buffalo trespass.

This concludes my observations on the enemies of the coffee-tree. However, I must add a few words on the insects commonly found on coffee-estates, without being injurious, and the cause of their presence there.

Most conspicuous amongst these are the black stag-beetle (two spec. *Lucanus*), the bright green carpenter-beetle (five spec. *Camposternus*), and the white and black carpenter-beetle (two spec. *Alaus*). These insects live, during the imperfect stages of their existence, in the rotting logs which lie about amongst the coffee. The large white, fleshy grubs, with brown heads, are the larvæ of the stag-beetle ; the long, cylindrical, sluggish brown worm, is that of the *Camposternus* ; and the larva of the *Alaus* is black, rather depressed, active, and pugnacious. On attaining the perfect state these insects come forth, and, of course, are seen upon the coffee, where the stag-beetle will now and then attack a cluster of berries. The *Camposterni* feed upon honey-dew and *Acari*, and occasionally devour perhaps a bug. From this reason they are exclusively found upon coffee-trees, whereas the *Lucani* and *Alaus* fly about and are met with elsewhere. The smaller kinds of white grubs found in the rotting logs are the larvæ of the flat, black beetles found with them (three or four spec. *Passalus*). These larvæ have only two pairs of well-developed legs, are harmless, and must not be confounded with the “white grub,” the larvæ of cockchafer. About December, a grey weevil (*Astycus* spec.) is found upon the trees, and the blossoms, which come forth some months later, are frequented by various insects allied to the English rose-beetle (*Clinteria*, *Tæniodera*, *Popilia*, *Singhala*), but none of these appear to do much harm.

A bugged tree presents, on a fine sunny day, generally a

very animated, and, to the entomologist, highly interesting picture—a perfect microcosm—a small world of its own.

Besides some of the insects just alluded to, and perhaps some gaudily-coloured butterfly, numerous Hymenoptera (especially Formicidæ, Sphegidæ, and Ichneumonidæ), several Phryganidæ and Diptera resort to it, and a bright green Mantis pounces constantly out from behind the leaves upon the unwary flies. I believe that twenty-five different species of insects might easily be gathered off a single coffee-tree on such an occasion. None of these insects do any injury to the tree, nor to the bug either, most of them resorting to the tree for the sake of the honey-dew, and some in order to prey upon the smaller insects which are attracted by this sweet substance. Amongst the Phryganidæ (caddice-flies), is very common the *Chimarrha auriceps*, Hag., which is red, with black wings, feelers, and eyes. I mention this insect particularly, because Westwood (Introduction to Entomology, vol. ii. p. 69) says, that the caddice-flies in their perfect state take no nourishment. This, however, is not so in the species which frequent the coffee-tree.

The Mantis of the coffee-tree (*M. tricolor*, N.) is green, lower wings reddish, with large blackish spot at posterior margin. The female is 1" long, expanse of wings $1\frac{1}{2}$ "; the male considerably smaller. The young larvæ are black. The eggs are deposited upon coffee-leaves in cocoon-like masses of $\frac{5}{8}$ " in length, not including a long point to which the mass is drawn out on either end, and which would make it upwards of 1" long. These nests are very delicate cake-like structures, much less coarse and substantial than those of the larger species. Amongst the flies, there is, about December, a fine large Tephritis with green eyes and variegated wings. I have not observed its larva to reside in any part of the coffee-tree.

Further Remarks on Lightning Figures, &c. By CHARLES TOMLINSON, Lecturer on Science, King's College School, London. (Plate I.)

In a paper read before the Physical Section of the British Association at Manchester in September last, and inserted in the October number of this Journal (vol. xiv. p. 254), I have attempted to show that the tree-like impressions which are sometimes found on the bodies of men and animals that have been struck by lightning, are produced, not by any photo-electric action, as has been supposed, but by the figures which the lightning itself assumes in striking the earth. In that paper the method of producing these figures by the discharge of a Leyden jar was given, and all that was wanted to complete the theory was a similar figure due to the action of the lightning itself. Such a case was observed by Charles Pooley, Esquire of Weston-super-Mare, during a thunder-storm which passed over Oakley Park, near Cirencester in July 1857. An ash-tree was struck by lightning, and on the inner surface of the torn-off bark some ramified lightning figures were found. An account of the accident, together with a drawing of the tree, and specimens of the bark, were forwarded by Mr Pooley to Professor Faraday, who has kindly placed them at my disposal on the present occasion.

Mr Pooley says: "The storm came from the north-west, and was accompanied with heavy rain. The first force of the electric discharge was expended on a branch north-west of the tree, which it barked and shivered to pieces. The fluid then passed through the fork of the tree without injuring that immediate part, but descending the south-west side, cut a clear line about $1\frac{1}{2}$ inch in width out of the bark, and loosened the bark to the extent of $1\frac{1}{2}$ foot on each side of it. The seam gradually widened as it reached the knotty roots. The point of interest, however, is in the circumstance, that on the inner surface of the fragment of the bark, which I picked up within half an hour after the accident, is to be found the actual impress of the passage of the electric flash.

"On it may be seen the tongue-like coruscations by which



Three Portions of the inner
surface of the bark.



Ash-Tree struck by Lightning,
shewing the track of the discharge



the force of the electric fluid expended itself, and which are gouged out, roughened, and slightly charred at the edges.

"Several other trees were struck by lightning on that and the succeeding days, all of which I visited in the neighbourhood, but on none of them could I find a trace resembling this, nor have I ever seen a similar instance, where the likeness of the flash is preserved. In the longer piece it is the more distinct. I have placed a bit of pink paper to denote the upper end, from which the progress of the coruscation can be easily traced."

The letter, of which the above is an extract, is dated 1st February 1858. On examining the specimens of bark at the Royal Institution in November 1861, or three years and a half after the accident, they had become somewhat warped, and the inner surface had assumed a brick-red colour in drying. The track of the lightning was not very distinct, blending as it did with the general colour of the surface; while the contraction in drying and the alteration in colour had doubtless obliterated some of the lines. I can therefore only represent it as it appeared to me in the following drawing; but Mr Pooley, in a letter to me, dated November 23, 1861, says, "The inside lining of the bark was not brick-red when I found it, but almost white, yellowish white; and the lightning coruscations were as vividly distinct as if they had been burnt in by a red-hot iron, the margins of each stroke being somewhat less charred than the central line of each stroke. The brickish red colour it has assumed by drying and exposure to the air."

Such is the instructive and interesting case furnished by Mr Pooley. That it does not often occur may arise from two circumstances: *First*, That a scientific witness is seldom at hand to give evidence when such a case arises; and, *secondly*, the extreme heat and mechanical violence of the lightning stroke may obliterate these ramified marks after they have been formed. And, even when spared by the lightning, the majority of observers would probably not think them worthy of notice and record. We do, however, occasionally find some slight notice of these figures in an almost unconscious expression of the reporter. Thus, in a case given in the

twenty-third volume of the "Comptes Rendus," a house in the Island of Zante was struck by lightning, and a young man killed while in bed. In the *post-mortem* examination the passage of the lightning was traced along the body, from a wound under the right foot of more than an inch in length, along the leg and thigh, up the back to the neck. The track was of a dark brown or black colour, and the skin all about it presented *ramified* scarifications. The hair was burnt off the body, including the eyelashes, eyebrows, and hair of the head. On the middle of the right shoulder were six circular marks of a flesh colour, and well defined on the blackened skin. These circles were of different sizes, and corresponded with those of six gold pieces which the young man wore on his right side, in a belt that passed round his body, at the time of the accident. It is supposed that an ascending stroke of lightning entered the right foot, passed up the body to the coils, from them to the shoulder, *carrying and fixing an impression of them* (but how it is difficult to explain), and then bounded off to the window, by which the fluid disappeared. The room smelt strongly of burning sulphur and bitumen, which was accounted for by the charred flesh and clothes.

A case where similar deep wounds were produced is reported by M. Goyon in the "Comptes Rendus," vol. xlv. The brig *La Félicité*, en route for Algiers, was struck by lightning near the Cape de Garde, on the 16th December 1856. Six men were thrown down and fearfully wounded, and in one case the wounds were blackened as if by charcoal. The men were landed, and taken into the hospital, and the medical officer, reporting on the case of one of them on the 12th of January, says, "Les bords de la plaie étaient surmontés par des croûtes recouvrant de gros boutons charnus. Son aspect démonstrait du reste que non seulement le derme mais encore une épaisse couche de tissu cellulaire, avaient été compris dans l'escarre." This was the worst case, on account of the man resting with his leg against the mast at the time it was struck. Another man was struck in the mouth; and during the next few days, the whole of its mucous membrane, including that of the tongue, came away in shreds. The teeth also were blackened, as if by charcoal, and loosened.

Cases of this kind may be multiplied to almost any extent; but in nearly every case, when faithfully reported, there is something that cannot well be explained by known electrical laws. But the enormous scale on which Nature works may perhaps account for effects which our puny efforts fail to imitate. The duration of the electric discharge is so excessively short, that it is difficult to understand how its heat can have time to act in producing such extensive effects of fusion, carbonisation, and mechanical expansion. The charring of the wood of a tree struck by lightning is sometimes very decided, as in the case recorded by M. Boussingault in the "*Comptes Rendus*," vol. xxii., where the lightning struck a pear-tree in a field by the side of the road from Wörth to Reichshoffen, 5th May 1843, at 2 A.M. The trunk was 3 metres high, partly hollow, and the diameter near the ground 50 centimetres. The leaves and bark were not injured by the lightning, with the exception of some centimetres square of epidermis near the point where the trunk divided into two great limbs. There the tree was completely split into two nearly equal parts, the lightning following the inner wall of the trunk. At 1 m. 50 from the bifurcation, the wood was impressed with a fuliginous matter, similar to the smoky trace of a candle on a cold surface. Lower down the black matter was more decided, but quite superficial. Still lower, at a distance of 50 centimetres from the soil, the wood had the appearance of the *charbon roux* used in making gunpowder. At 20 centimetres above the soil the carbonisation was complete, and a portion of the wood had been consumed. The fire was discovered at 4 A.M., and the people said that the smell of sulphur was insupportable. M. Boussingault compares the odour to that produced by the distillation of vinegar from wood.*

Cases are recorded in which trees in leaf have been parched

* Scientific observers have compared the odour arising from a lightning stroke in a building to that of phosphorus, nitrous acid, ozone, &c. There is a case recorded by M. Desormery in which the odour was *aliaceous* rather than sulphurous. The smell of sulphur is a popular expression for almost every case of accidental combustion accompanied by smoke and odour. It is stated, however, that sulphur has actually been found on the surface of gilt metal objects that had been blackened by lightning. Thus, on Sunday the 14th of June 1846, the parish church of *St Thibaud-de-Conz*, three leagues from Chaberny,

by atmospheric electricity passing over them. M. Peltier (*Des Trombes*, Paris, 1840) records a case of this kind which occurred on the 18th June 1839 in the neighbourhood of Châtenay, in the department of Seine et Oise, during a thunder-storm, or rather two storms, which were raging at different elevations at the same moment, and repelling each other. The lower storm communicating with the earth, its thunder ceased; but a powerful attraction was experienced on the earth's surface, all light bodies being drawn upwards in the form of an inverted cone. Trees which encountered the storm had their leaves parched and made brown by the lightning, while the side away from the storm preserved all its freshness and verdure. Some of the trees were split into laths, and large boughs were divided into fibres like those of a worn-out broom. Ears of corn were also parched on the side of the storm, and the leaves of vines trailed in front of a house were also parched up.

When trees in full leaf have a brown and withered appearance, it is common to refer the effect to lightning. Such, however, is not always the case. In September 1861, my attention was directed to some trees in General Buckley's park, close to the road leading from Salisbury to Downton, which it was said had been struck by lightning during the preceding spring. Three trees had been attacked; the centre tree had its foliage parched and embrowned, and half of each tree on the side of this central one was in a similar condition, the remaining halves preserving their freshness and verdure. On examining these trees, I was led, from the absence of signs of mechanical violence, to suspect that lightning had not produced the charred appearance. Accordingly, I wrote to General

was struck by lightning. The church was filled with a thick smoke, the smell of which was compared to that of gunpowder. The chandelier and various gilt ornaments were struck and blackened, and next day M. Bonjean scraped off some of the powder, and had no difficulty in detecting sulphur in it. He thinks that sulphide of hydrogen rather than sulphurous acid accompanies the lightning, and assists in blackening the metal. So completely does the idea of the sulphur odour possess the popular mind in connection with lightning, that in a case brought before the Academy of Sciences at Paris of a sailor struck by lightning, on recovering his consciousness he became sea-sick, and the vomit smelt strongly of sulphur!

Buckley's agent, to ask for his explanation of the matter, and received the following satisfactory reply, dated October 5th, 1861 :—

“ Sir,—In reply to your note of the 1st inst., I beg to state that I do not believe the trees situated in General Buckley's estate were struck by lightning at all. I have been in the habit of making a large quantity of gas-lime compost at the foot of the trees, and am inclined to believe that the vapour from this mixture caused the leaves to shrivel and die off. They came out a second time, but as the process was repeated, they were again withered. There is no mark on the trunks or branches of the trees.—Your obedient servant,

“ W. MOORE.”

It should be stated that these trees, being separated from the road by the park palings, the preparation of the compost would not have attracted much attention, while the withered trees themselves were prominent and very curious objects.

The action of lightning on trees has led to statements which Science keeps in view, while she waits for their verification. It was once supposed that the lightning struck some trees in preference to others, but it has been repeatedly proved that the favoured trees have been often struck. Foresters are of opinion that those trees, even of the same species, which have the most abundant foliage are more liable to be struck than those which are more scantily clothed. Nor are the tallest trees always the mark for the thunderbolt. M. Desormery, while travelling in Auvergne, was struck down by a discharge which at once drove a hole through a cottage wall, magnetised an iron vessel resting against it on the inside so that nails flew up to it, killed a child, and struck the shorter of two poplar trees, one of the branches of which was divided into a bundle of laths of so remarkable a regularity as to resemble a product of man's industry. (*Comptes Rendus*, tome xxviii.) There are many other cases in which trees of comparatively low elevation have been struck, while tall ones near at hand have been spared. In 1856, M. Dureau de la Malle informed the Academy of Sciences at Paris, that during the preceding

seven years three bignonias in the plantations surrounding his house had been struck by lightning, although these shrubs were topped on all sides by larches, pines, acacias, and plane trees.

In the "Gardener's Chronicle," a few months ago, it was stated that a common oak-tree in Scotland had been struck by lightning some years before; and on recovering from its injury, it was remarked in the following spring that the leaves were *variegated*, and it is said that they have continued to be so every year since. A verification of this statement would be desirable.

On the Aqueous Origin of Granite. By ALEXANDER BRYSON,
F.R.S.E.*

For many years after Dr William Smith, the father of English geology, had published his "Tabular View of the British Strata," in 1790, geology was studied only in the direction of palæontology. Physical, chemical, and dynamical geology were left by the great masters of the science almost unregarded since the early years of the Royal Society of Edinburgh, when its meetings were made brilliant by discussions on the theory of the earth, the formation of granite, trap, and porphyry, by Hutton, Hall, and others. When Dr Smith announced his great discovery, that fossils prove the relative ages of formations, geologists were naturally tempted to leave their former fields of inquiry as barren, and enter with enthusiasm on the study of palæontology, as promising richer results; thus, for nearly half a century they were content to receive the speculations of Hutton and the experiments of Hall as demonstrative of the plutonic origin of the primary rocks.

In attempting to prove the aqueous origin of granite, I will not adduce any views trenching on the domain of the theologians who assailed Hutton and his followers, believing as I do that geology has no necessary connection with cosmogony—metamorphosis, not morphism, being its proper study.

* Read before the Royal Society of Edinburgh, April 29, 1861.

Speculations on the origin of granite are nearly coeval with the foundation of this Society. In the first volume of its Transactions, Hutton has stated, in his celebrated paper on the Theory of the Earth, "That the nature of granite, as a part of the structure of the earth, is too intricate a subject to be here considered, where we only seek to prove the fusion of a substance from the evident marks which are to be observed in a body." "We shall therefore only now consider one particular species of granite; and if this shall appear to have been in a fluid state of fusion, we may be allowed to extend this property to all the kind. The species now to be examined comes from the north country, about four or five miles west from Portsoy, on the road to Huntly. I have not been upon the spot, but am informed that this rock is immediately connected or continuous with the common granite of the country. This, indeed, appears in the specimens which I have got, for in some of these there is to be perceived a gradation from the regular to the irregular sort. This rock may indeed be considered, in some respects, as a porphyry; for it has an evident ground, which is felspar in its sparry state; and it is in one view distinctly maculated with quartz, which is transparent, but somewhat dark coloured. Considered as a porphyry, this specimen is no less singular than as a granite. For instead of a siliceous ground maculated with rhombic felspar, which is the common state of porphyry, the ground is uniformly crystallised, or a homogenous regular felspar maculated with the transparent siliceous substance. But as, besides the felspar and quartz, which are the constituent parts of the stone, there is also mica, in some places it may with propriety be termed a granite." Hutton further states, "that it is evident from the inspection of this fossil that the sparry and siliceous substances had been mixed together in a fluid state, and that the crystallisation of the sparry substance, which is rhombic, had determined the regular structure of the quartz, at least in some directions."

The mineral here alluded to by Hutton is the well-known graphic granite of Portsoy. Where he found the evidences of its fluid fusion I have not been able to discover; that it was in aqueous solution, I shall attempt in the sequel to show. This

was a very narrow basis on which Hutton reared so large a generalisation that the granites were of igneous origin, but Sir James Hall came to his aid, and most ingeniously endeavoured to strengthen Hutton's position. On this point Sir James Hall remarks, "To a theory, however, which embraces so great a variety of objects, some difficulties must be expected to occur, and this is the more likely to happen that, though the agents employed in it be such as we are well acquainted with, yet they are introduced as acting in circumstances very different from those in which we usually see them act. Of these difficulties the most considerable appeared to him to be the following: In granite, which contains quartz and felspar, it frequently occurs that felspar is seen with the form of its crystals distinctly defined, whilst the quartz is a confused and irregular mass, being almost universally moulded upon the crystals of felspar. Now, were it true that all granite is formed by fusion, the very contrary, it would seem, ought always to take place, as felspar is very easily melted, and quartz resists the greatest efforts of heat that have hitherto been applied to it. This difficulty is obviated thus. It is well known that when quartz and felspar are pounded and mixed together, the mixture may without difficulty be melted and run into a kind of glass, the felspar serving as a flux to the quartz. The same fact may be stated in another way, by considering the felspar when melted as a fluid in which, as in a menstruum, the quartz is dissolved; and in this view we may expect, by analogy, that phenomena similar to those of the solution of salt in water should take place.

"Now it is certain that when excessive cold is applied to salt water, the water is frozen to the exclusion of the salt, the ice obtained yielding fresh water when melted, and the salt, when the experiment is pushed to the utmost, separating from it in the form of sand. Why should not the same thing happen in the solution of quartz in liquid felspar, when the mass is allowed to cool below the point of congelation of the menstruum?

"The felspar may crystallise separately from the quartz, as we have seen pure ice formed separately from the salt, in

both cases the *congelation* of the solvent being simultaneous to that of the dissolved substance. Hence the crystals may mutually interfere with each other's forms, and we may naturally expect to see quartz moulded on crystals of felspar, or the reverse.

"In answer to an objection which might be urged against this reasoning, viz., that the result of the fusion of granite is a glass in which no crystallisation can be seen, an accidental experiment was produced, which happened at one of the Leith glass-houses a few weeks previous to the reading of this paper. A quantity of common green glass having been allowed in a great mass to cool gradually and very slowly, it was found to have lost all the properties of glass, being opaque, white, very hard and refractory, and wholly composed of a set of crystals which shot into some cavities in a determinate form.

"The same principle seems to point out the theory of all kinds of granite, and shows their connection with one another and with all the other unstratified bodies. If quartz, felspar, schorl, mica, garnet, &c., happen to be melted together, the most fusible substance of them all may be considered as the menstruum in which all the rest are dissolved, and we may suppose that these various dissolved substances may differ amongst themselves in their properties of solution, as salts differ from one another, so that some of them may be more soluble in the menstruum when very much heated than when it is comparatively cold, and others may be as soluble in it when little warmer than its point of congelation as when raised to a much higher temperature." Hall submitted powdered limestone and calc spar to heat and pressure; at fifty atmospheres he obtained a compact limestone, and at eighty-six a crystalline marble. These experiments and generalisations date from the beginning of this century. We can scarcely now appreciate their full intrinsic worth; but how our fathers estimated them is evident, that this experiment of Hall was made the ground of a flag of truce to convey the news of it to the French Academy—a fine instance of the cosmopolitan nature of science.

To these views of Hutton and Hall, Dr Murray, in his "Comparative View of the Huttonian and Neptunian Sys-

tems of Geology," thus replies: "The structure and appearances of granite as a fossil have been brought forward by Dr Hutton as favourable to his hypothesis. There can be no doubt that this rock has at one time been fluid. Its constituent parts, particularly the felspar, and sometimes the quartz, are crystallised, and it not unfrequently contains other crystallised fossils. This fluidity, from which it has been consolidated, Dr Hutton conceives is proved to have been that of fusion, from the parts of the granite impressing each other. The species of granite termed graphic is stated particularly as establishing this deduction. In it the felspar is crystallised in its usual rhomboidal form, and these crystals impress the quartz, put it aside as it were, and give it its particular situation along the side of the rhomboidal felspar." "Hence," says Hutton, "this granite is not a congeries of parts, which, after being separately formed, were somehow brought together and agglutinated; but it is certain that the quartz at least was fluid when it was moulded on the felspar." And "this fluidity was not the effect of solution in a menstruum, for in that case one kind of crystal ought not to impress another, but each of them should have its own peculiar shape."*

Murray further replies, "It has already been shown how simultaneous consolidation may take place from solution, and the structure of granite can from this circumstance furnish no argument against its aqueous origin. But it affords the clearest demonstration that it has not been formed by fusion. Felspar is a substance incomparably more fusible than quartz, the first varying from 120 to 150, the other being 4043 of Wedgewood's scale.

"It is a proposition, therefore, self-evident and undeniable, that in the same mass quartz could not be fluid when felspar was solid; and therefore, since in this graphic granite the quartz is moulded on the crystallised felspar (and in the greater number of granites the felspar is crystallised while the quartz is not), the fluidity whence both have been consolidated cannot have been fusion from heat." "The force of this argument from the crystallisation of felspar in granite

* Illustrations of the Huttonian Theory by Professor Playfair, p. 86.

may be estimated by a very simple consideration. If the appearance of this fossil had been the reverse of what it is; if the quartz had crystallised and shot through the felspar, would it not have been brought forward as a proof, or at least as a strong presumption, that both had consolidated from fusion? Yet the fact, as it is, is still stronger in proving that such could not have been their origin, since it is an evident impossibility that in two substances fused together, the most fusible should concrete before the one that was least fusible, or required the greatest heat to keep it fluid. Had the former even been congealed by some cause, of which we can form no conception, the high temperature keeping the other fluid, must have again immediately fused it. . . . Besides the crystallisation of felspar in granite, regular crystals of it are not unfrequently found embedded in quartz, a proof, which cannot be eluded, that the felspar has become solid while the quartz remained fluid, contrary to what must have happened from the known fusibilities of those substances if they had consolidated from fusion."

These admirable views of Murray found little favour with the geologists of the time, who were glad to leave a field where each party sought to support their theories rather than seek for truth; and it was not until Lonchamp, in 1826, showed veins of iron pyrites in the hot springs of Chaudesaignes, that geologists turned again their attention to the study of chemical and physical geology. The first important researches which had for their object to show the part water might have in the formation of minerals and rocks is due to Becquerel, Fuchs, Silliman, Dana, and Bischoff. The first had succeeded in obtaining, by a humid method, the conditions and appearances which galena and sulphide of antimony present in nature. Since the labours of these eminent chemists, Delesse has concluded, from a chemical analysis of the eruptive rocks at the point of junction with the other strata, that the changes effected have been more through the aqueous vapour charged with different salts or acids than by heat.

It had many years ago suggested itself to the sagacious mind of Davy, that the occurrence of fluids in the cavities of crystals seemed to point to an aqueous origin under pressure.

Sir David Brewster has also devoted much time to those fluid cavities in minerals, and has enriched the Transactions of the Royal Society of Edinburgh by his labours on this subject.

Mr Sivwright, and the late William Nicol, to whom I am mainly indebted for my collection of fluid cavities, both added much to our knowledge of the subject. The bearing of these observations on the aqueous origin of granite will appear in the sequel of this paper.

In 1856 I had the pleasure of showing to Mr Sorby my extensive collection of crystals containing fluid cavities, and stated my views on the subject of their formation. He has published an elaborate paper on the subject, well worthy the attention of the physical geologist, though I cannot concur in his generalisations.

During ten years' experimental investigation into the structure of rocks, relative to their formation (more particularly granite), my attention was specially directed to the microscopic structure of the various pitch-stone veins abounding in Arran; I was much struck with the similarity of their structure, and the marked difference they exhibit when compared with sections of granite and its various mineral constituents. On extending my observations to obsidian, Marekanite, a volcanic glass from Lake Marekan in Kamtschatka, and also to the well-known glassy obsidian of Bohemia, I found they all exhibited a structure analogous to the pitch-stones of Arran, and also all glass slags where the heat has been long continued, combined with slow cooling.

This structure, peculiar to igneous formed substances, is generally radiated in a stellate form, and although usually microscopic, many slags often exhibit it on a large scale. It is so marked a character that no one whose eye is tutored to microscopic observation can fail to recognise at once a mineral substance of plutonic origin.

In granite, on the other hand, the characteristic microscopic structure is as persistent as in pitch-stone obsidian, &c., but totally different. In the many experiments I have made I have never succeeded in obtaining an instance of stellate structure; while the constant occurrence of cavities con-

taining fluids have convinced me that, if pitch-stone and glass are types of igneous formed substances, granite must be of aqueous origin.

In the fluid cavities so abundant in topaz, Cairngorm, beryl, tourmaline, felspar, all constituents of granite, the same general appearance prevails. The cavities are seldom entirely filled with fluid, an air-bubble occupying more or less of the cavity.

After many hundred experiments on such cavities, I found that, when exposed to a temperature of 94° Fahr. (the mean heat of the experiments as detailed in my note-book), the bubble disappeared, the fluid entirely filling the cavity; at the mean temperature of 84° the bubble reappeared. I was thus led to infer that those cavities could not have been filled at a temperature above 84°, and certainly not above 94° Fahr.

As another proof that these cavities could not have been filled when the temperature of the surrounding rock was higher than the temperature above indicated, I beg to call attention to the fact, that the bubble of air occupied always a much smaller portion of the cavity than the fluid,—a condition which could not obtain if, as other writers on this subject hold, the fluids were enclosed under intense heat and pressure. Fig. 1 exhibits the stellate appearance found in various glass slags; fig. 2 shows the microscopic view of a section of the pitch-stone from Arran; and fig. 3 represents the fluid cavities in the topaz and quartz of granite.



Fig. 1.

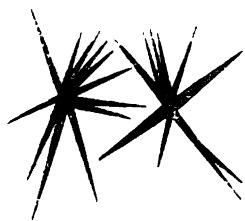


Fig. 2.



Fig. 3.

For the purpose of determining with accuracy the temperatures at which the bubble vanished and reappeared, I constructed an apparatus represented in fig. 4.

It consists of a microscope with a hollow tin or copper stage A, having a tube in the centre to admit light from the re-

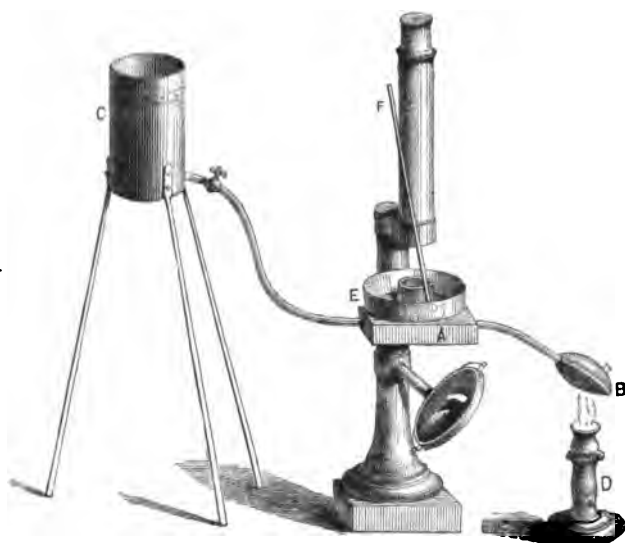


Fig. 4.

flector. At one side, and inserted into the stage, is a small tin retort with a stopper B; at the other side a tube is inserted, and is attached to a reservoir of water C, from which the hollow stage and retort are filled. On applying heat to the retort by means of a spirit lamp D, any required temperature under the boiling point of water may be obtained in the stage and retort.

Above the stage is placed an iron saucer E, in the centre of which an iron tube is rivetted, through which the light is admitted. This vessel is filled with mercury, and in it is placed an upright thermometer F, with the bulb shielded with cork or any other good non-conductor; by this means it indicates the actual temperature of the mercury bath. The mineral containing the cavities is cemented with Canada balsam to a plate of glass 3×1 inch, and is floated on the surface of the mercury, so that the glass and mercury are in absolute contact. When the temperature is raised until the bubble nearly disappears (which is seen by its contraction),

the spirit-lamp is withdrawn, and the vanishing point carefully watched and the temperature noted. The stopper of the retort is then withdrawn, and the stopcock of the reservoir of water opened, so that the temperature of the stage and mercury bath is soon reduced, and the ebullition or reappearance of the bubble takes place when the temperature is again recorded.

By this method I obtained very accurate results, as they were always consistent when the same cavity was observed.

When small chips of minerals are to be observed, and where the difficulty of grinding and polishing two parallel surfaces is great, it is common to place the small objects in a cell covered with thin glass, and fill the cell with a fluid of the same refracting index as the mineral. By this method I found that the porphyry of Dun Dhu in Arran (which most geologists describe as of igneous origin) was full of cavities contained in the doubly acuminate crystals of quartz for which this remarkable porphyry is distinguished. I also discovered, in the doubly acuminate crystals of quartz found in the saliferous gypsums of India by my friend Dr Andrew Fleming, thousands of fluid cavities, and the quartz impressed with the gypsum; and as no geologist would hold that this formation was of igneous origin, and as the quartz was impressed by the gypsum, if not contemporaneous, must have been subsequent to it; and as the same phenomena were exhibited in the porphyry of Dun Dhu, I am forced to the conclusion that the latter was as much aqueous in its origin as the saliferous gypsum from India.

Another fact here is worthy of record. I possess a specimen of quartz from California; it contains a crystal of iron pyrites, to which is attached a small mass of zinc blende, while over these three is laid a covering of gold. It is clear that as all those metals are fusible at a much lower temperature than the quartz, they must have aggregated during a gelatinous condition of the silica; and further, as the sulphides of the three metals are in chemically combining proportions, any heat which would have fused the quartz would have made an alloy or a slag, in which chemically combining proportions could not occur.

Nor is the question of the gelatinous condition of quartz so difficult, since Professor Graham has shown in his recent researches in dialysis that pure silica can be held in solution in water to the extent of 15 per cent.

Perhaps no finer proofs can be obtained of the quartz of granite having been gelatinous than in those specimens which contain schorl or tourmaline, so frequently found in Aberdeenshire. Fig. 5 is a good example of many such in my collection, and is singularly instructive.



Fig. 5.

It is well known to mineralogists that tourmaline crackles and splits with a small increment of temperature, and therefore could not have been present during a molten condition of the quartz; and that it was crystallised prior to the solidifying of the latter, is proved by the schorl impressing the quartz. Further, from many careful measurements of the peculiar fractures of the tourmaline and its contortions, and also from the amount of quartz which had entered into the fissures of the former, I am led to believe that the quartz, while in the process of crystallization, expanded $\frac{1}{4}$ th of its bulk. Such a force appears to me to be amply sufficient to cause all the upheavals and disruptions which other geologists have accounted for by supposing a molten condition of the primary rocks. If this view is correct, and if the highest peak is granite, and we know that the lowest is granite, it follows that, as the highest mountain is only $\frac{1}{8}\frac{1}{2}$ part of the radius of the earth, a thick-

ness of the crust of 168 miles is quite sufficient to yield expansive force to raise the highest peak of the Himalayan range. It may be objected, in regard to the temperature at which it seems the fluids were enclosed, as being too high for the normal temperature of the earth; but it must be recollected that pressure and also solidification from fluid conditions develop heat.

Organic Method in Zoology. By HUGH DOHERTY, M.D.

The gorilla, in its approximation to the "human form divine," has caused uneasiness, perhaps, to many consciences already more or less disturbed by the development theories of the "Origin of Species," which have been revived of late, with somewhat of a plausible appearance of natural truth being contrary to revealed religion. There cannot be a real discrepancy between natural and spiritual truth, although erroneous theories of natural organic laws may hold the mind in thrall for a time and sow confusion in the consciences of pious men.

The so-called rationalistic theory of the "Origin of Species" nowhere proves the fact of any original metamorphic evolution by "natural selection;" but merely a development of individual organs and faculties by growth, exercise, experience, and education, from which facts it assumes the possibility, and even probability of metamorphic evolution in a genetic or creative sense. The assumption is entirely gratuitous, without the shadow of a demonstration.

If the theory were true, it would only prove that the original germs of animal creation were less perfect in powers of metamorphic evolution than the germs of procreation in the animal kingdom, and that the latter were, in fact, the continuation of the former, in a perpetual renewal of the first creation.

These questions need not be discussed, for nothing is known of the origin of species which deserves the name of a rational theory. Cuvier believed in the distinct creation of each species.

Man is evidently a part of the animal kingdom on our

globe,—the highest type in the realm of vertebrata. He is the brain and mind of the collective animal kingdom, distinct from other types of organism, as the brain and nervous system in the human body are distinct from other systems in the individual organism; and as man, having the highest cerebral development, is the highest organism in nature, so other species are inferior in degree, and correspond in rank with the inferior organs and systems of the individual organic unit.

All the higher vertebrata are more or less allied to man in general form and structure; and the monkeys are but little nearer to the human form than many other types of dumb creatures. Anthropoid apes are not less speechless than the common monkeys, nor are these less animal than other brutes in all their instincts and peculiarities. There is no more reason to suppose that man proceeds from apes than that apes proceed from dogs, and these again from lower types of vertebrata. It is mere hypothesis and wild conjecture. Organic method, duly understood, will scatter to the winds unsound hypotheses; but this is yet to be developed as a positive science.

The following outline of such a method may be, and no doubt is, imperfect; but it will serve at least to show the tendency of modern thought on these important questions, and preserve the minds of the unlearned from being disturbed by theories of natural science, which may be multiplied in various ways with an equal show of plausibility.

There is, no doubt, order and method in the universe, and in the plan of creation on our globe; and this plan is manifest in every variety of organism within the limits of investigation by the human mind.

Anatomy and physiology have already made the organs of the body and their special functions known to us in all minuteness, but the laws of organic unity are still a riddle without a satisfactory interpretation. We have not a comprehensive view of plan in the creation, nor a knowledge of the principles of natural organic method, either in the individual organism, or in the different collective units of organic forms, such as the vertebrata, articulata, mollusca, radiata, &c.

Organs, and groups of organs, in the body, have been well

described, but series and systems have been hardly noticed. Individuals and congeneric groups of species have been well observed in different classes of the animal and vegetable kingdoms; but series and systems of congeneric groups have been less accurately studied by the eminent zoologists and botanists who have given their names respectively to many contradictory and unsatisfactory methods of systematic classification, and contending theories of the "origin of species."

Cuvier, De Blainville, Macleay, Van Der Hoeven, Owen, and many other eminent zoologists since Linnæus, have published each his own peculiar system of arrangement, based on what he deems some leading features of organic structure; but none of these agree in definite principles of method, or in the application of their views to natural divisions and associations.

Buffon, Geoffroy St Hilaire, and many other men of eminence in natural science, have theorised on the probable development and metamorphic evolution of all known species, including man himself, from a few simple germs of the lowest type and rank in nature. Cuvier and many other noble minds have denied the rationality of such a theory, and maintained the common faith of Christians with regard to the creation. The rules of method in division and classification are still in a chaotic state, even amongst those who are most eminent in science. Some lay stress on number as a key to natural divisions, others follow structural peculiarities without regard to theories of number. One of these views need not exclude the other; but as yet no leading principles of method have been universally recognised.

According to Mr Kirby, "the number *five* assumed by Macleay as a basis of method consecrated in *nature*, ought to yield to the number *seven*, which is consecrated both in *nature* and in *Scripture*." "Metaphysicians," he observes, "enumerate seven principal operations of the mind; musicians seven principal tones; and opticians seven primary colours. In *Scripture*, the abstract idea of this number is *completeness, fulness, perfection*." He believes that Mr Macleay's *quinaries* may be resolvable into *septenaries* by more elaborate investigations;" but we may here state that the number

seven is not the only numerical basis of natural division in organic method.

Richard Owen makes four primary divisions in his classification of mammalia. His distinctions of the *Lyencephalous*, *Lisencephalous*, *Gyrencephalous*, and *Archencephalous* subclasses are, no doubt, known to all your readers, and therefore need no comment here. Many points of interest have been dwelt upon in these cerebral distinctions, but they do not form a complete system of divarication.

In lieu of the brain alone, or in connection with concomitant modifications of structure in other parts of the organism, we may take the whole body as a type of organic unity, and the most obvious natural divisions of the organism as a basis of numerical distinction and methodical grouping. These are the following distinct systems: the *alimentary*, the *vascular*, the *generative*, the *nervous*, the *osseous*, the *muscular*, and the *cutaneous* systems; with the organs of sense which belong to them respectively. In the vascular system, we include air-vessels, blood-vessels, and water-vessels, or the respiratory, the circulatory, and the urinary series of organs in the body. The rank of each vertebrate mammalian organism may be seen in the cephalic structure, as remarked by Owen, but rank alone is not a sufficient basis of primary divisions in a natural organic method.

Taking this septenary view of the distinct systems, with the additional quinary view of the five senses, we have a natural numerical division of the complex unity exemplified in an individual vertebrate organism; and this principle of natural subdivision in a simple organic unity, suggests the idea of a similar numerical law of subdivision in the parts of a collective organic unity, such as that of the mammalian class of vertebrata. The collective ideal type may differ from the individual type in some minor points, such as those of a *trunk* in the elephant, a *marsupium* in the kangaroo, and other exceptional points of structure in certain species hardly shown, or only rudimentally developed in the highest individual organism, such as that of man; but these details may be embodied in a general formula of method, including all the individual varieties of type and form.

Let us see, then, how this law of order, in organic grouping, as exemplified in the individual organism, may be applied to that collective organism of vertebrata embodied in the class mammalia. Seven natural alliances may easily be placed in parallel with the seven systems of the human body; not, perhaps, with any preconceived idea of analogy or correspondency, but merely as a fact of natural organic subdivision; thus,—

Seven Alliances of Mammalia.

- | | |
|----------------------------------|---------------------------------|
| 1. The Quadrumanal alliance, 2. | 5. The Equine alliance. 7. |
| 2. The Plantigradal alliance, 4. | 6. The Ruminant alliance, 6. |
| 3. The Digitigradal alliance, 3. | 7. The Pachydermal alliance, 5. |
| 4. The Bimanal alliance, 1. | |

These alliances may seem at first imperfect, but a subdivision into orders will make them appear less so. In the Quadrumanal alliance there are the Simial and the Lemural orders; in the Plantigrade, the Ursine and Marsupial orders; in the Digitigrade, the Feline and the Canine orders;—each containing subdivisions to be noticed presently. The Bimanal alliance forms but one order, and this order but one family, and, indeed, but one species; and yet we place it in parallel with the whole nervous system in man, which ranks even higher than the other systems. The brain is the recognised organ of the mind in man, and man is the acknowledged head of the creation.

The Equine alliance, also, forms one order only, or one family. The Ruminant alliance is much more complex, and may be naturally subdivided into a horned order and a hornless. The Pachydermal, properly so called, forms but a single order; but the Rodents are so nearly allied in many leading points of structure with the Pachyderms that we place them together in the same alliance.

This arrangement of the seven alliances forms a dozen orders of mammalia; thus:—

Class Mammalia in parallel with different Systems of Organs in the Human Body.

- | | |
|--|--|
| G Simial order: (vascular system.) | F Canine order: (digestive system.) |
| ee Lemural order: (vascular sense organs.) | ff Feline order: (digestive sense organs.) |

E Ursine order : (generative system.)	BB Hornless ruminants: (vibratory sense organs.)
EE Marsupial order: (generative sense organs.)	B Horned ruminants: (muscular system.)
D Bimanal order: (nervous system.)	AA Rodental order: (radiatory sense organs.)
C Equine order: (osseous system.)	A Pachydermal order: (cutaneous system.)

These parallels suppose the nervous system most predominant in man; the digestive system in canine and feline species; the generative peculiarities of structure most predominant in the plantigrade alliance; the cutaneous system in pachydermata; and so of all the rest. We need not dwell on the subdivisions of those orders which are the most simple in this list, but a few words of explanation may be necessary for the others.

By placing the Digitigrade alliance in parallel with the natural subdivisions of the alimentary system in the human body, we shall find the following numerical distinctions of organs and series in both:—

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|------------------------------|--|
| 1. The mouth and oesophagus. | 6. The anus and rectum. |
| 2. The stomach. | 7. The gland ducts of the alimentary system (salivary, pancreatic, hepatic). |
| 3. The duodenum. | |
| 4. The small intestines. | |
| 5. The large bowels. | |

The natural families or series of groups in the Digitigrade alliance are the following:—

- | | |
|---------------|---------------|
| 1. Felidæ. | 5. Enhydridæ. |
| 2. Hyænidæ. | 6. Mustelidæ. |
| 3. Viverridæ. | 7. Profelidæ. |
| 4. Canidæ. | |

The first four series in this system or alliance need not detain us, as their natural subdivisions are already recognised by systematic zoologists. In the fifth series we place the *walrus*, the *seal*, the *kalan* (enhydra), and the *otter*, as natural genera belonging to one series or family. The sixth series needs no comment, and in the seventh we place the semiplantigrade aberrant genera of digitigrades—namely, *procyon*, *nasua*, *ailurus*, and *cercoleptes*, or racoons, coatis, the panda or wah, and the kinkajou, to which the *binturong* should

be added; and probably with this group, instead of with *viverridæ*, the *suricate* and the *mangue*, or *croscarchus obscurus*, should be classed.

The Canine order is placed in parallel with the main organs of the alimentary system, and the Feline with those of special sense and articular rank in the same system. Thus, *Felidæ*, *Viverridæ*, *Mustelidæ*, and *Profelidæ* form one order, in the majority of which the claws are more or less retractile, as a main distinguishing characteristic; while *Hyænidæ*, *Canidæ*, and *Enhydridæ*, form another order with unretractile claws, as a leading difference of structural peculiarity. The words canine and feline are perhaps too special to denote these orders; but new names would probably be less convenient.

In the Ursine order we have a like difficulty in the name, as in this general division are included three distinct series or families,—namely, *Ursidæ*, *Edentidæ*, and *Insectivoridæ*. The latter have been classed as an order, but they are only entitled to rank as a subordinate series in this order.

Nearly all marsupial animals are more or less plantigrade; and as the Ursine order here described are carnivorous, insectivorous, frugivorous, and omnivorous, they are just as well entitled to the rank of a sub-class, as the marsupiatæ, which have had this honour mainly on account of their diversified habits of feeding. Marsupial types are merely aberrant forms of plantigrade mammalia, neither more numerous in species nor diversified in structure than the rodents, which rank only as an order.

Cheiroptera we class as aberrant forms of *Quadrumanæ*; *Sirenia* and *Cetacea* as aberrant types of *Pachydermata*;—the reasons will be explained in a forthcoming work not yet ready for the press. Meanwhile we may observe that Cuvier, the most eminent of all zoologists, recognised these natural affinities.

It has been said that man is a microcosm, an image of creation as well as of the Creator; and in this view of organic parallels we see a likeness between the microcosm and the macrocosm, organised on the same principle of order, number, and harmony, in every part of the collective unity. This outline of organic method is applied to the mammalian class only

of vertebrata; but the individual vertebrate organism corresponds in completeness of parallel to the whole realm of vertebrate organic unity, the connective tissues being parallel with the oviparous classes, and the main tissues with viviparous mammalia; thus,—

Mammals, . . .	(principal organic tissues.)
Birds, . . .	(glandular connective tissues.)
Reptiles, . . .	(fibrous areolar connective tissues.)
Fishes, . . .	(adipous and serous connective tissues.)

These parallels may be deemed quite arbitrary by those who differ widely from the author in habitual modes of thought; and there is no reason why every one should not hold independent views of natural organic method and of natural science generally, as well as of theology or the interpretation of revealed religion, until final views of natural and spiritual truth enable man to see at once the difference between perfect and imperfect theories in every sphere of thought and understanding. Man knows little, guesses much, and quarrels with the guessings of his neighbour if they differ from his own.

Nature is no more answerable for the shortcomings of "natural science" than Scripture is responsible for the discrepancies of spiritual science or theology. The want of faith in revelation, we may safely say, will not enable us to dive into the mysteries of nature, by the mere conceit of deeming ourselves rational, and those who differ from us, superstitious. Natural science has done nothing yet, nor do we think it ever can do anything, to injure true religion, although popes and theologians have often entertained erroneous views of science, and philosophers erroneous ideas of religion.

On the Inapplicability of the New Term "Dyas" to the "Permian" Group of Rocks, as proposed by Dr Geinitz.
By Sir RODERICK IMPEY MURCHISON, F.R.S., D.C.L.,
LL.D., &c., Director-General of the Geological Survey of
Britain.

In the year 1859 M. Marcou proposed to substitute the word "Dyas" for "Permian," and summed up his views by saying that he regarded "the New Red Sandstone, comprising the Dyas and Trias, as a great geologic period, equal in time and space to the Palæozoic epoch or the Graywacke (Silurian and Devonian), the Carboniferous (Mountain-limestone and Coal), the Mesozoic (Jurassic and Cretaceous), the Tertiary (Eocene, Miocene, and Pliocene), and the recent deposits (Quaternary and later)."!! *

As that author, who had not been in Russia, criticised the labours and inductions of my associates, de Verneuil and von Keyserling, and myself, in having proposed the word "Permian" for tracts in which he surmised that we had commingled with our Permian deposits much red rock of the age of the Trias, I briefly defended the views I had further sustained by personal examination of the rocks of Permian age in various other countries of Europe.†

It was, indeed, evident that M. Marcou's proposed union of the so-called Dyas and Trias in one natural group could not for a moment be maintained, since there is no conclusion on which geologists and palæontologists are more agreed, than that the series composed of Roth-liegende, Kupfer-Schiefer, Zechstein, &c., forms the uppermost Palæozoic group, and is entirely distinct in all its fossils, animal and vegetable, from the overlying Trias, which forms the true base of the Mesozoic or Secondary rocks.

Owing to such a manifest confusion respecting the true palæontological value of the proposed "Dyas," we should probably never have heard more of the word, had not my distin-

* See "Dyas et Trias de Marcon," Bibliothèque Universelle de Genève, 1859.

† See "American Journal of Science and Arts," 2d series, vol. xxviii. p. 256, —the work of M. Marcou having attracted more attention in America than in England.

guished friend, Dr Geinitz of Dresden, recently issued the first volume of his valuable palæontological work, entitled "Dyas, oder die Zechstein-Formation und das Rothliegende."* In borrowing the term "Dyas" from Marcou, Dr Geinitz shows, however, that that author had been entirely mistaken in grouping the deposits so named with the Trias or the Lower Secondary rocks, and necessarily agrees with me in considering the group to be of Palæozoic age.

As there is no one of my younger cotemporaries for whom I have a greater respect as a man of science, or more regard as a friend, than Dr Geinitz, it is painful, in vindicating the propriety and usefulness of the word "Permian," to be under the necessity of pointing out the misuse and inapplicability of the word "Dyas."

The term "Permian" was proposed twenty years ago for the adoption of geologists, without any reference whatever to the lithological or mineral divisions of the group; for I well knew that a certain order of mineral succession of this group prevailed in one tract, which could not be followed out in another. After surveys during the summers of 1840 and 1841, of extensive regions in Russia in Europe, in which fossil shells of the age of the Zechstein of Germany, and the Magnesian Limestone of England, were found to occur in several courses of limestone, interpolated in *one great series* of red sandstones, marls, pebble-beds, copper-ores, gypsum, &c., and seeing that these varied strata occupied an infinitely larger superficial area than their equivalents in Germany and other parts of Europe, I suggested to my associates, when we were at Moscow in October 1851, that we should employ the term "Permian" as derived from the vast government of that name, over which and several adjacent governments we had traced these deposits.

In a letter addressed to the late venerable Dr Fischer von Waldheim, then the leading naturalist of Moscow, I therefore proposed the term "Permian"† to represent by one un-

* Leipzig, 1861.

† See Leonhard's "Jahrbuch" of 1842, p. 92; and the "Philosophical Magazine," vol. xix. p. 418, "Sketch of some of the Principal Results of a Geological Survey of Russia."

ambiguous geographical term a varied mineral group, which neither in Germany nor elsewhere had then received one collective name* adopted by geologists, albeit it was characterised by one typical group only of animal and vegetable remains. As the subdivisions of this group in Germany consisted, in ascending order, of Roth-liegende, with its overlying strata of Weiss-liegende, Kupfer-Schiefer, and Lower and Upper Zechstein, and in England of Lower Red Sandstone and Magnesian Limestone, with other accompanying sands, marls, &c., so well described by Sedgwick,† the name of "Permian"—purposely designed to comprehend these various strata—was readily adopted, and has since been generally used. Even Geinitz himself, as well as his associate Gutbier, published a work under the name of the "Permische System in Sachsen."‡ Naumann has also used the term in reference to the group in other parts of Saxony; whilst Göppert has clearly shown that the rich Permian Flora is peculiar and characteristic of this supra-carboniferous deposit. In England, France, and America, no other term in reference to this group has been used for the last fifteen years.

The chief reason assigned by Geinitz for the substitution of the word "Dyas" is, that in parts of Germany the group is divided into two essential parts only—the Roth-liegende below, and the Zechstein above, the latter being separated abruptly from all overlying deposits.

Now, not doubting that this arrangement suits certain localities, I affirm that it is entirely inapplicable to many other tracts.

* It is true that the term *Pénéen* was formerly proposed by my eminent friend, M. d'Omalius d'Hallo; but as that name, meaning *sterile*, was taken from an insulated mass of conglomerate near Malmédy in Belgium, in which nothing organic was ever discovered, it was manifest that it could not be continued in use as applied to a group which was rich in animal and vegetable productions.

† Trans. Geol. Soc. London, New Series, vol. iii. p. 37.

‡ I may here note that the great Damuda formation of Bengal, with its fossil flora and animal remains, including Saurians and Labyrinthodonts, described by Professor Huxley, has recently been referred (at least provisionally) to the Permian age, by Dr Oldham, the Superintendent of the Geological Survey of India. In fact, Dr Oldham actually cites the plant *Teniopteris* of the "*Permian beds of Geinitz and Gutbier in Saxony*," in justification of his opinion. (See "*Memoirs of the Geological Survey of India*," vol. iii. p. 204.)

For, in other regions besides Russia, the series of sands, pebbles, marls, gypseous, cupriferous, and calcareous deposits form but one great series. In short, the Permian deposits are for ever varying. Thus in one district they constitute a *Monas* only, in others a *Dyas*, in a third a *Trias*, and in a fourth a *Tetras*.*

In this way many of the natural sections of the North of Germany differ essentially from those of Saxony; whilst those of Silesia differ still more from each other in their mineral subdivisions, as explained in "*Siluria*," 2d edition, particularly at p. 342. Near the northern extremity of the Thüringerwald, for example, and especially in the environs of Eisenach, an enormous thickness of the Roth-liegende, in itself exhibiting at least two great and distinct parts, is surmounted by the Zechstein, thus being even so far tripartite, whilst the Zechstein is seen to pass upwards to the east of the town, by nodular limestones, into greenish and red sandy marl and shale, the "*Lower Bunter Schiefer*" of the German geologists. The same ascending order is seen around the copper-mining tract near Reichelsdorf, as well as in numerous sections on the banks of the Fulda, between Rotheburg and Altmorschen, where the Zechstein crops out as a calcareous band in the middle of escarpments of red, white, and green sandstone.†

But in showing that in many parts of Germany, as well as in England, the Zechstein has a natural, conformable, and unbroken cover of red rock, I never proposed to abstract from the Trias any portion of the Bunter Sandstein or true base of the group, as related to the Muschelkalk by natural connection or by fossils. I simply classed as Permian a peculiar thin red band (*Bunter Schiefer*), into which I have in many localities traced an upward passage from the Zechstein, and in which no triassic shell or plant has ever been detected.

* See "*Siluria*," 2d edit. 1859, and "*Russia in Europe and the Ural Mountains*," 1846.

† On two occasions (1853-54) Professor Morris accompanied me, and traced with me these relations of the strata; subsequently, when Mr Rupert Jones (1857) was my companion, we saw other sections clearly exhibiting this upward transition which I have described. Since then, Professor Ramsay, when at Eisenach, convinced himself of the accuracy of the fact that the Zechstein passes up conformably into an overlying red cover. My note-books contain many additional evidences, which I have thought it not necessary to repeat.

On my own part, I long ago expressed my dislike to the term Trias; for in common with many practical geologists who had surveyed various countries where that group abounds, I knew that in numerous tracts the deposits of this age are frequently not divisible into three parts. In central Germany, where the Muschelkalk forms the central band of the group, with its subjacent Bunter Sandstein and the overlying Keuper, the name was indeed well used by Alberti, who first proposed it; but when the same group is followed to the west, the lower of the three divisions, even in Germany, is seen to expand into two bands, which are laid down as separate deposits on geological maps of Ludwig and other authors. In these countries, therefore, the Trias of Alberti's tract has already become a Tetras. In Britain it parts entirely with its central or calcareous band, the Muschelkalk, and is no longer a Trias; but, consisting simply of Bunter Sandstein below, and Keuper above, it is therefore a Dyas; though here again the Geological surveyors have divided the group into four and even into five parts, as the group is laid down upon the map No. 62, "Geographical Survey of Great Britain."

The order of succession in the Permian group all along the western side of the Pennine chain or geographical axis of England, proves the impossibility of applying to it the word "Dyas;" for over wide areas in Shropshire and Staffordshire it is one great red arenaceous series, with a few subordinate courses of calcareous conglomerate. Following it to the north, Mr Binney has demonstrated that the fossils of the Zechstein show themselves in the heart of red marls which occupy on the whole a superior part of such a red series; and in tracing these rocks northwards he has demonstrated that there are, besides, two great underlying masses, first, of conglomerates and breccias, and next of soft red sandstones, the latter attaining, as he believes, a thickness of not less than 2000 feet. Here then the Permian may be considered a Trias. Professor Harkness, in a memoir he is preparing, estimates the thickness of these Lower Sandstones and Conglomerates to the N.E. of West Ormside, in Cumberland, at 4000 to 5000 feet, and shows that they are surmounted by marl-slates bearing plants, thin-bedded red sandstone, grey shale, and

sandstone and limestone, the latter—the representative of the **Magnesian Limestone**—being covered by red argillaceous shale.* Now, in all these cases the Permian is a series divisible into three or more parts. But when we follow the same group into Scotland, it there parts with its calcareous feature, and, becoming one red sandstone of vast thickness, is again a *Monas*.

I have entered into this explanation because my friend, Dr Geinitz, has seized upon one illustration in my work "*Siluria*," which shows that in certain tracts, where the Zechstein or Magnesian Limestone is subordinate to an enveloping series of sandstones, the Permian of my classification is *there* as much a tripartite Palæozoic group as the Trias of Central Germany is a triple formation of Mesozoic age. Unless, therefore, the data to which my associates and self have appealed, in the work on "*Russia and the Ural Mountains*," and which I have further developed in *Memoirs* read before the Geological Society and in my two editions of "*Siluria*," be shown to be inaccurate, I hold to the opinion that there are tracts in which the Zechstein is simply a fossiliferous zone in a great sandstone series, to which no division by numerals can be logically applied. Even if I do not appeal to the natural evidences in England, Russia, and parts of Germany, but refer to those tracts where the Zechstein or Magnesian Limestone has no natural red cover, I may well ask, Does not the word "*Permian*," in the sense in which it was originally adopted, serve for every tract wherein the uppermost palæozoic fossil animals and plants are found, whether the strata of which the group is composed form, as in Russia and Silesia, one great series of alternations of plant-bearing sandstones and marls in parts containing bands of fossiliferous limestone, or whether, as in other tracts, the Zechstein stands alone (as near Saalfeld), or in others, again, where the group is tripartite, and even quadripartite? Quite irrespective, however, of

* The red clay or argillaceous shale which covers the limestone is surmounted at Hilton, in Cumberland, by 500 feet of red sandstone, which, though perfectly conformable to the subjacent Permian rocks, he considers to belong to the Bunter Sandstein of the Trias. Here, then, as in Germany, the limestone may have a red cover, and yet the Bunter Sandstein be intact.

the question of whether there are or are not localities in Germany where the Zechstein passes upwards into a red rock, which forms no true part of the Bunter Sandstein of the Trias, we have only to look to the environs of Dresden, on the one hand, and to Lower Silesia on the other, to see the inapplicability of the word "*Dyas*" to this group.

Near the capital of Saxony, Dr Geinitz himself pointed out to me that the Roth-liegende is there divided into two very dissimilar parts; and these, if added to the limestone which is there interpolated, or to the true Zechstein of other places, constitute a Trias. Again, Beyrich, in his Map of Lower Silesia,* has divided the vast Roth-liegende of those mountains into Lower and Upper, the two embracing *eight* subdivisions according to that author.

In repeating, then, that the word "*Permian*" was not originally proposed with the view of affixing to this natural group any number of component parts, but simply as a convenient short term to define the Uppermost Palæozoic group, I refer all geologists to the very words I used in the year 1841, when the name was first suggested. In speaking of the structure of Russia, I thus wrote: "The Carboniferous system is surmounted to the east of the Volga by a vast series of beds of marls, schists, limestones, sandstones, and conglomerates, to which I propose to give the name of "*Permian System*;" because, although this series represents *as a whole* the Lower New Red Sandstone (Rothe-todte-liegende) and the Magnesian Limestone or Zechstein, yet it cannot be classed exactly, whether by the succession of the strata or their contents, with either of the German or British subdivisions of this age."†

After pointing to the governments of Russia over which such Permian rocks ranged, I added: "Of the fossils of this system, some undescribed species of *Producti* might seem to connect the Permian with the Carboniferous era; and other shells, together with fishes and saurians, link it more closely to the period of the Zechstein, whilst its peculiar plants appear to constitute a Flora of a type intermediate between the epochs of

* See also "*Siluria*," 2d edit. p. 343.

† Phil. Mag. xix. p. 419.

the New Red Sandstone or Trias and the Coal-measures. Hence it is that I have ventured to consider this series as worthy of being regarded as a system."*

In subsequent years, having personally examined this group in the typical tracts of Germany as well as of Britain, I felt more than ever assured that, from the great local variations of mineral succession of the group, the word "*Permian*," which might apply to any number of mineral subdivisions, was the most comprehensive and best term which could be used, the more so as it was in harmony with the principle on which the term *Silurian* had been adopted.

Apart from the question of the substitution of the new word "*Dyas*" for the older name "*Permian*," I take this opportunity of expressing my regret that some German geologists are returning to the use of the term "*Grauwacke Formation*," as if years of hard labour had not been successfully bestowed in elaborating and establishing the different *Palæozoic* groups, all of which, even including the Lower Carboniferous deposits, were formerly confusedly grouped under the one lithological term of the "*Grauwacke Formation*."

Respecting as I do the labours of the German geologists who have distinguished themselves in describing the order of the strata and the fossil contents of the group under consideration, I claim no other merit on this point for my colleagues de Verneuil and von Keyserling and myself, than that of having propounded twenty years ago the name of "*Permian*" to embrace in one natural series those subformations for which no collective name had been adopted. Independently, therefore, of the reasons above given, which show the inapplicability of the word "*Dyas*," I trust that, in accordance with those rules of priority which guide naturalists, the word "*Permian*" will be maintained in geological classification.

* In my last edition of "*Siluria*" I have spoken of the *Permian* as the Uppermost *Palæozoic group*, but have not deemed it a system by comparison with the vast deposits of Carboniferous, Devonian, and *Silurian* age.

Address delivered at the Opening of the Session of the Royal Society of Edinburgh, on Monday, 2d December 1861, by the Very Rev. Dean RAMSAY, LL.D., Vice-President of the Society.

It is with no affectation of humility, it is with no mock modesty that I earnestly bespeak your kind indulgence for the discharge of the duty to which I have been called this evening. My diffidence in this matter arises from no want of interest in the work assigned to me, but from knowing how much I lack that extent of knowledge and that degree of experience which seem to be required for the position in which I am placed, and for such an audience as I have the honour to address. I find different scientific associations adopt different rules. In some cases the secretary makes, in name of the council, a general report of the whole proceedings during the past year; in fact, very much in the business style of the secretary of a railway company. In some cases, the address is delivered on the anniversary of the society by the president, who makes a distribution of its medals and prizes previous to his vacating his office.

The Royal Society of Edinburgh has only of late years adopted the practice of an address from the chair on the first meeting of the Session, with notices of the deceased members during the year; the medals and prizes being distributed usually towards the end of the Session. The address on the first meeting of last Session was delivered by our recently elected President, the Duke of Argyll; and it was well observed on that occasion, I think by Lord Neaves, that the address itself was the best proof of the Society having chosen their President well and wisely.

As to the statistics of the Society, I may mention that eight members have died during the past year :—

Rt. Hon. The Earl of Aberdeen.	Professor More.
Robert Bell, Esq.	Sir James M. Riddell, Bart.
Rt. Hon. Lord Campbell.	The Rev. Dr James Robertson.
John Gordon, Esq., of Cairnbulg.	E. D. Sandford, Esq.

Sixteen new members were elected during the past year :—

execute them so ably and so gracefully. The productions of the last Session, and the attendance at the evening meetings, indicate, then, a continued activity and interest in the cause of science. And we notice this fact as supplying the answer to an objection which we have heard raised against the Royal Society of Edinburgh, and against other associations of the same character, viz., that their day had gone by; that they were well suited to a period when there was little or no scientific current literature, but that their place has been superseded by periodicals—that is, by scientific magazines and journals, to which men of science will now prefer sending their papers, rather than to the less popular and less known Transactions of societies. Experience has proved the objection altogether fallacious. Societies have done for science and literature what could have been accomplished in no other way. There is the advantage of personal intercourse at their meetings, whether ordinary or extraordinary,—of funds for prizes,—of libraries, and of the general prestige of men of high place and high reputation being associated in bodies under sanction of Royal patronage. The Transactions of home and foreign societies would themselves form a scientific library of considerable extent. The library of the Royal Society of London now exceeds 40,000 volumes, chiefly on scientific subjects, and in mathematical works is surpassingly rich. At no time were such associations, either in this country or the continent of Europe, more active and more efficient. No doubt this very activity and efficiency have produced a change, which, to a certain extent, *must* affect the old scientific institutions. The change to which I refer is due not only to the great increase of the *number* of such institutions, but to the great subdivision of the labour in scientific inquiries. The Royal Society of London was founded in 1663. Its general object was the promotion of Science and Literature. The vast number of illustrious names connected with that great Society, and the extent of research manifested in its Transactions, amounting to 200 volumes, are well known to all whom I address. Other similar institutions were formed in London in subsequent years. The Royal Society of Edinburgh followed, and many provincial associations throughout England. Of these the Literary and Philosophical Society of Manchester, instituted 1781, has been long distinguished. Dr Percival was one of its early supporters. His papers, and communications from Mr Dalton, Dr Henry, and others, have ever been

had in high esteem. At Liverpool, Bristol, York, Bath, Leeds, Exeter, and other places, large sums of money have been expended in buildings for the meetings, museums, libraries, lecture-rooms of similar societies, and were called forth to meet the growing taste for scientific study, and the vast increase of persons in all professions and ranks of life who delighted in natural history, physical science, and the study of history, of literature, and philosophy. We now find the operations of our learned societies becoming associated with our social system itself.

The *history* of the Royal Society of London becomes an important work, and is, in fact, a history of science itself during the period when the Society was in action.*

In reference to the history of scientific institutions, we can scarcely omit to notice the endeavours that have been made to draw the members closer together in social as well as scientific relations—such as dinners, holding *conversazione* meetings, and other friendly unions. I hope it will not be considered unbecoming in this address to mark how completely the *scientific* association is adapting itself to the *social* system, and becoming part and parcel of common life. It is from this circumstance, I apprehend, that a certain part of the history of the Royal Society of London has lately excited so much attention. An account of it has been printed for private circulation by Admiral Smyth, to whom the necessary documents connected with it were intrusted. I mean its *Dining Club*. The annals of its proceedings commence in 1743; but Admiral Smyth, and others, zealous in all branches of archæology, are persuaded that the club dates much further back. The club was at first called the “Royal Philosophers;” and although the archives of the Royal Society are unfortunately deficient on many points of its proceedings, they are very minute in their account of the dinners of the Royal Philosophers. Thus we have the satisfaction of knowing the precise dinner to which the Royal Philosophers sat down, 27th October 1743—a dinner, let it be remembered, eaten at one o’clock, and a pretty solid one:—

Turkey boiled and oysters.
Calves head hashed.
Fowls and bacon.
Chine of mutton.
Apple-pie.

Two dishes of herring.
Tongue and udder.
Leg of pork and peas.
Sirloin of beef.
Plum-pudding.

* History of the Royal Society of London, by Birch.

The dining club is now generally adapted as a concomitant of the learned association, and with very pleasant results. But the Royal Society of London were so desirous to consider their dinners part and parcel of the *Society* itself, that it was one of their early rules to fine any member a guinea who called it a club.

The Astronomical Society have long had a dining club in conjunction with their scientific meetings. From what connection or analogy with sidereal investigation I do not know, but one invariable dish at the astronomical dinners is black pudding.

The dining club of the Royal Society of London has evidently, then, been considered a very important appendage; indeed, Admiral Smyth remarks: "The hospitality of the Royal Society Club has been of *material utility* to the well-working of the machine." "This is proved," he goes on to state, "by the number of men of note, both in ability and station, who have there congregated previously to repairing to the evening meeting of the body at large; and many a qualified person, who went thither a guest, has returned a candidate." It has been a sound policy, therefore, as Admiral Smyth conceives, which so early in the history of the Royal Society dictated the formation of a dining club in connection with the more scientific portion of the body. It introduced a bond of unity of a different character from the scientific bond. Dr Johnson and other learned men have attached great importance to their dinner, and were not in humour for pursuing literary thoughts where it was wanting or where it was bad. When the discussions were going on about the propriety of having a cook attached to the French Institute, an eminent Paris judge told La Place, as a reason for having a cook, that he considered the discovery of a new dish far more important than the discovery of a new planet, and added this reason for the opinion: We have already quite enough of planets, but we can never have too many good dishes.

It soon became evident, as years rolled on, that a greater subdivision of scientific labour must follow upon the older societies, formed as they were for general scientific purposes. Enthusiastic cultivators of particular branches of science wanted something more exclusive. The first actual movement in this direction was, I believe, the Linnean Society, founded in 1788 for promoting the study of zoology and botany, as these sciences had been organised and advanced by the immortal naturalist whose name gave the character to the association.

This society had a further division in its Botanical Section promoted by such men as Brown, Lindley, and Hooker, whose object was to pursue, unfettered by the artificial classification of Linnæus, the natural system of Jussieu as a more philosophical system, and already vigorously pursued on the continent by the elder Decandolle and other great botanists. Societies formed for promoting special objects in science and natural history sprung up in every quarter. Thus, we have the Antiquarian Society, the Royal Astronomical Society, the Geographical Society, Geological Society, Entomological Society, the Horticultural Society, the Meteorological Society; and to show the extended character of these subdivisions, I may mention the Royal United Service Institution, exclusively devoted to questions connected with warfare, whether by sea or land. Few persons unconnected with the naval and military professions are aware of its precise object and character, or of the extent of its operations. It is termed the "Royal United Service Institution," because it has a Royal charter. It is in regard to machinery very much like our own.* It has vice-presidents, a library, museum, meetings, and proceedings; papers are read, and transactions published, and the subjects of those papers are all strictly bearing upon military and naval service. To show the character of the topics chosen for these papers, I will read over a few of those already published in their Transactions, many of which, I have been told, are exceedingly able, and admirably illustrated by models, maps, and drawings. For instance, the whole of the number for August is occupied with a dissertation on Iron-Cased Ships, by Captain Halsted, R.N. June number contains a paper on Photography and its Application to Military purposes; another on the Military Forces of the Nations of Europe; one upon Swiss Targets and Rifle Ranges. There is a paper in a late number on National Defence, called the Rifle and the Rampart; one upon the Sanitary Condition of the Army; one upon Recreations for Soldiers and Sailors; one upon Rifled Ordnance, &c.; all connected with warlike affairs. Then there are models of ships, forts, arms, battles; and there is a collection of relics or trophies, naval and military. For example, as to naval relics, there are the sword worn by Nelson when he took the "San Josef," the chronometer used by Cook in his voyages of discovery, the signal book of

* The Crown its Patron.

the "Chesapeake," and many others. As to military relics, they have the swords of Cromwell and of Wolfe, the sash with which Sir John Moore was lowered into his grave, Napoleon and Tippoo Saib's rifles, relics of Waterloo, Inkermann, Sebastopol, and others. The Duke of Wellington took much interest in this institution in all its departments, and entered most kindly into the wishes of the Council regarding digging up and placing the skeleton of his favourite horse, which he rode at Waterloo, into the museum, as already they had the skeleton of the Arab rode by Napoleon at Waterloo. The design never was accomplished, but the museum of relics called forth a quiet jocular remark from the great commander to Sir Charles Napier; and as the jokes of the Duke of Wellington are rare, I may mention it in passing. It is the more amusing, as Napier used to tell the story himself. Whilst the negotiation about the skeleton of the Duke's horse was going on, Charles Napier, the naval officer of the name, had been dining at Walmer Castle with the Duke, as his ship lay in the roads. On going away, Napier was putting on his cocked hat, as he was in uniform. Charles Napier, it is well known, was not very nice as to his wardrobe; and so, as they had been talking about the museum, the Duke, after eyeing the cocked hat, suggested, "Napier, you should put your cocked hat into the museum—just the place for it."

The immense increase of scientific associations for the furtherance and pursuit of separate branches of human knowledge is no more than what might have been expected, and is, in fact, the natural supply of that vastly increased and increasing demand for knowledge in all departments of study, especially in those which relate to inquiries connected with the physical sciences. Nor does this increase at all act injuriously upon the older societies, or deteriorate from the usefulness or importance of their office. It rather calls out their exertions, and places them in a *more* important position. It was utterly impossible that they should of themselves meet the whole growing demand except by a subdivision of their own body, which would not certainly have been so efficacious an arrangement as the formation of new bodies. These children, if we may so call them, of the parent societies, instead of being rivals and opponents, are I apprehend, their best aids and coadjutors. The younger branches take, as we might say, the heavy work of departments, whilst the older institutions take that general charge which extends itself

to the whole field of human knowledge. No subjects are excluded from the parent society, but none should have a monopoly there. Whatever other societies do they are ready to do; and in their Proceedings a full and free admission should be given to those subjects which cannot so properly find a place elsewhere. I cannot help thinking that this great multiplication of associations for the exclusive advancement of so many distinct branches of natural science, should lead the older and parent societies to *extend* as much as possible the basis of their own operations. The student who finds only his own pet study advanced by the association which bears its name, naturally looks for a greater variety of subjects in the Royal Society, to which the name of no particular science is attached. The course now pointed out to us is to take the widest range of questions connected with the pursuit of truth; and this seems to me a strong argument for a more frequent introduction of literary papers. Botanical or entomological societies draw round them only botanists and entomologists: The Royal Society should draw round it men of all pursuits. The continued absence of literary papers naturally excludes the full sympathy and cordial co-operation of those who are keenly interested in literature, but who do not take interest in minute details on scientific questions, whether of natural history or natural philosophy. My argument, then, in one word is this: That as ordinary scientific societies attract only those who pursue the studies to which they are specially dedicated, so the Royal Society is intended to attract and interest all classes of men of research and intelligence. I am aware that I require apology for making these remarks; but I offer them not only under a deep feeling of their importance, but from an assurance that persons whose valuable aid and countenance we would be proud of are kept away, because the Society's papers and discussions are so seldom upon questions other than those connected with physical inquiries.

After these remarks upon the labours of the Society past and future, I would say a few words on those of our body who have departed this life since we met within this hall last December. I think the practice adopted of late years by the Royal Society of Edinburgh, and which has been pursued by other kindred associations,—I mean the practice of introducing, at the opening meeting of every Session, a short biographical reference to the deceased members of the past year,—is a most becoming and appropriate arrangement.

Whilst, on the one hand, it enables the chairman to offer a suitable testimony to many a distinguished example of zeal for literature and science, and of well-directed labour in their cause, and whilst he is thus enabled to enlarge upon ingenious discoveries and useful inventions, at the same time it indicates a very becoming feeling of interest in the Society towards its individual members as fellow-citizens, and as companions embarked in a common cause, and is a graceful recognition of them in their private character, showing the friendly bond by which we are united, as associates of an ancient and distinguished literary and scientific institute. Sir R. Murchison seems to have had this feeling strong in his mind during his address to the Geographical Society in 1859. In taking leave of the chair he says, "With truth, I take leave of my dear friends as the really good fellows of the Royal Geographical Society;" and surely the Royal Society of Edinburgh has just cause to be proud of many names who now bear, and who have in times past borne, the title of Fellows. The present roll of the members embraces many persons distinguished not only at home, but amongst the philosophers of Europe. In the list of past members are recorded names imperishable in the annals of history,—names associated with the highest productions of the human mind. This we may fairly say, when amongst our departed members we find such names as Hume, Robertson, Black, Adam Smith, Sir Humphry Davy, Sir Walter Scott. Now, in looking back upon the changes which the past year has made in our list of members, we find that those whom we have lost were all men of a certain degree of weight and influence in their position in society; all were men much respected by their cotemporaries, and men whose death called forth many sincere expressions of sympathy and regret. It is somewhat remarkable that none of these members belonged, properly speaking, to the *scientific* department of the Society. No one had adopted the pursuit of pure mathematics, or their application to the laws of nature. None were geologists, chemists, or naturalists, beyond that general acquaintance and intelligence possessed now by most men of education. Our deceased members were well known, however, in connection with the business of their day. We have to mark a past career which is associated with a high place, indeed the highest place, in the government of the country. We see the vacant places of men who were no ordinary proficient in the discharge of life's duties, and the more particular duties to

which *they* were called, whether it were as ministers of state, as judges, as professors in the university, as landed proprietors, as theologians, or lawyers. The following is the list of departed Fellows of the Society:—

Right Hon. the Earl of Aberdeen, K.G. & K.T.	Professor J. Shank More, Edinburgh.
Robert Bell, Esq., Advocate, Edinburgh.	Sir James Miles Riddell, Bart., Strontian.
Right Hon. Lord Campbell, London.	The Rev. James Robertson, D.D.
John Gordon, Esq., Cairnbulg, Aberdeenshire.	E. D. Sandford, Esq., Advocate, Edinburgh.*

Of the late members on our obituary list, the first is the name of a statesman, a man of the world, a scholar, an antiquary. George Hamilton Gordon, K.G. and K.T., fourth Earl of Aberdeen, was born in 1784, and died December 14th, 1860, at the ripe age of seventy-six. Although far from what would be called a man of brilliant talents, or of great powers of oratory, still, during this long life, few men were more distinguished as filling with much ability high and responsible positions, few were more respected for private worth, and few more generally known for scholar-like attainments. Lord Aberdeen was educated at Harrow, where he laid the foundation of a classical taste and acquirement such as I am disposed to think nothing can so effectually accomplish as an English public school. He went to St John's College, Cambridge, and graduated there in 1804. But previous to this he had been attached to the embassy at Paris, and had gone with Lord Cornwallis, who was there as our ambassador to negotiate the Peace of Amiens in 1801. He formed intimacies with many leading men of the day, and commenced that knowledge of continental politics for which he afterwards became so celebrated, and from which he was enabled so long to administer with much skill and ability the Foreign Department of the British Government.

He did not remain long in Paris in 1801, but before returning to England travelled in Greece, where he brought his classical attainments to bear upon his study of the beautiful architectural remains and interesting localities of the country. This sojourn in Greece (when access to foreign parts was less open to British travellers than it is at present) procured for Lord Aberdeen the

* The names are alphabetically arranged.

notice of his kinsman Lord Byron, who in the English Bards and Scotch Reviewers introduced his name with the well known line—

“The travelled Thane, Athenian Aberdeen.”*

The public official career of Lord Aberdeen; his frequent occupation of high place in the administration of his country's affairs; his close intimacy with the most distinguished foreign public characters of his time, especially his friendship with Guizot and Prince Metternich; his modification of opinion on many points of national policy, and of the high Tory principles with which he commenced life, which ultimately led to his heading a coalition ministry composed of politicians of all shades of opinion; his correspondence with Dr Chalmers on Scottish ecclesiastical matters, and his endeavours to prevent that which was not prevented taking place, viz. the disruption in the Scottish Established Church; his constant and undeviating advocacy of the policy of non-interference on the part of the British Government in continental relations, and his aversion to entering into war with Russia, and the temporary unpopularity which from that cause he incurred with his own countrymen;—these are all now matters of history, and belong to history, and we leave them to the historian.† As a late Fellow of the Royal Society of Edinburgh, we look more to the man and the scholar than to the politician. To whatever part of Lord Aberdeen's career we direct our attention we find everything that claims our respect and approval. As a landed proprietor his whole career was marked by energy, by skill, and great liberality. I am assured that on no property in Scotland were greater changes manifest under the direction of the proprietor than on his; and all changes were improvements. Old persons, I am assured, in the neighbourhood of Haddo House, speak of once barren moors becoming cultivated farms—once sterile tracts of country becoming clothed with beautiful and valuable timber. A friend who was on a visit to him shortly before his death, exclaimed, after

* In 1813 he returned to the Continent, and was our ambassador to the Austrian Court; there he was long engaged in cementing the alliance formed against the power of Napoleon. He was present at many great battles.—Lutzen, Dresden, Leipsic—Moreau died in his tent at Dresden; and it was his impressions received from these dreadful battles that gave Lord Aberdeen that great horror he entertained for war through life.

† A kind friend informs me that the best account of Lord Aberdeen's public life is a memoir by Comte de Jaumais, in the “*Revue de deux Mondes*.” But I have not had time or opportunity for consulting it.

Lord Aberdeen had been pointing out to him the success of his plantations in magnificent and extensive woods, "You don't mean that you planted all these yourself?" "Yes," replied the peer; "and perhaps you will believe what I have before told you, that my line was not politics, but farming." In this light of a Scottish proprietor, we must ever consider him as a patriotic and judicious benefactor of his country. Lord Aberdeen was for many years the efficient President of the Antiquarian Society of London, and no one was more fitted for such an honour. He was an accurate scholar, and a patient investigator into the remains of antiquity. It is curious to observe how Lord Aberdeen preserved, through all the circumstances and stirring incidents of an unusually exciting period of public affairs, the love of classical literature which he had imbibed at Harrow, at Cambridge, and at Athens. His mind had been early imbued with a fine taste for the best writers of Greece and Rome, and the effects were visible to the last. It is often, I believe, thus a taste for life—

"Quo semel est imbuta, recens servabit odorem
Testa diu."

We have specimens of his accurate scholarship and ingenious criticisms in his contributions to Walpole's "Memoirs on Turkey," and in his work on the "Beauty of Grecian Architecture."

In 1817 a book was published entitled "Memoirs Relating to European and Asiatic Turkey, Edited from MS. Journals, by Robert Walpole." It consisted of such extracts from the journals and portfolios of intelligent and learned travellers, who had of late years visited that interesting portion of the globe, as were calculated to throw light upon its present condition and ancient grandeur, its geography, antiquities, and natural history, recorded, too, in their own language. It is a very valuable and interesting collection. Amongst these papers are some very learned dissertations by Lord Aberdeen; one of these is upon the gold and silver coinage of Athens. A curious question had been agitated by scholars on the subject of Attic coinage, and many learned men have held that the Athenians never coined gold money at all. There was no doubt gold money, but it seems to have been in coins of other countries. Gold coin seems to have been the *stater* of Persia or Egina, or the ancient *δαρικός*, so called from Darius. Aristophanes speaks of gold coinage, but in his mocking way calls the pieces *πονηρά χαλκᾶ*, which

is not, as Corsini thinks, *copper* money, but base gold money,—i.e., gold alloyed with copper. Now, Lord Aberdeen discusses the question with much learning and ingenuity; and I will give his conclusion in his own words, as a specimen of his critical style, because scholars are agreed that he settles the question by a more satisfactory explanation of the difficulty than had been given by others.

“The currency of the *SILVER* money of Athens was almost universal, owing to the deservedly high reputation for purity which it possessed; and on this account we find several cities of Crete copying precisely in their coins the design, weight, and execution of the Attic tetradrachm, in order to facilitate their intercourse with the barbarians. It is possible that the general use and estimation of the produce of the Attic mines contributed to render the Athenians averse from a coinage of another metal, which, by supplying the place of silver money at home, might in some degree tend to lessen its reputation abroad.”

“The Attic silver was of acknowledged purity, and circulated very extensively; the Athenian merchants, particularly in their commercial dealings with the more distant and barbarous nations, appear frequently to have made their payments in it. The barbarians, being once impressed with these notions of its purity, the Government of Athens, in all probability, was afraid materially to change that styled appearance by which their money was known and valued among these people. A similar proceeding in the state of Venice throws the strongest light on the practice of the Athenians. The Venetian sechin is perhaps the most unseemly of the coins of modern Europe. It has long been the current gold of the Turkish empire, in which its purity is universally and justly esteemed; any change in its appearance on the part of the Venetian Government would have tended to create distrust.”

Lord Aberdeen in this volume gives an account also of two curious sculpture marbles found at Amyclæ in Laconia. Each of these two marbles represents a hand-basin surrounded with various implements of a female toilet—such as combs, pins, a bodkin, perfume-boxes, bottles, mirrors, curling-irons, toothpicks, and reticules, or, as some learned men believe, nightcaps. On one of these stones is an inscription containing the words, *Ανθουση υποστατηρια*; on the other an inscription containing the words, *λαοαγητα* and *μερια*. These by some are supposed to signify two priestesses—Anthusa and Laou-

geta being supposed the names of priestesses by whom the stones were dedicated.* Others, again, consider *στυγία* to be nothing more than a hairdresser, and *υποστυγία*, an under-hairdresser—the same as an *ἐμπλεκτρία*, or a tirewoman; and the stones, therefore, to be a sort of advertisement of their profession by Anthusa and Laoageta. Lord Aberdeen follows out these nice and critical inquiries with much learning and much patience, and with similar clear and convincing effects as in the case of the Attic tetradrachms.

The treatise of Lord Aberdeen, of which the title is “An Inquiry into the Principles of Beauty in Grecian Architecture,” was originally contributed as a preface to Mr Wilkins’ translation of Vitruvius. It was published afterwards in a separate form by the author, and has lately been brought out by Mr Weale, the architectural publisher, at the moderate price of one shilling. If we knew nothing of Lord Aberdeen’s scholarship except by this treatise, we should have abundant proof of its accuracy, its elegance, and its extent. The essay shows a masterly hand in treating the subject. Nearly all the celebrated buildings of ancient Greece are brought before the reader, and their characteristic features are discriminated with a skilful touch. The whole question of the origin of architectural forms is discussed in reference to the inquiry into the principles of beauty in Greek architecture, although I cannot help thinking that he loses sight of that point at times. Lord Aberdeen disputes, and indeed refutes, the theory of Burke on the sublime and beautiful, and supports himself the theory of beauty as grounded on association—the theory of Mr Alison, as developed in his *Essay on Taste*, and as admirably supported and illustrated by Francis Jeffrey in his celebrated critique on Mr Alison in the “*Edinburgh Review*.” I would speak with much diffidence on such a question, but I cannot help thinking there is very little satisfaction in these *theories* of beauty, and inquiries into the *principles* of beauty. The idea of beauty is too refined and too delicate to admit of such analyses and dissections. The application of female dialectics to beauty, vulgarly called a woman’s reason, is after all more satisfactory than analysis and theory. It is beautiful, *because* it is beautiful; so we say of the orders of Greek architecture. There is a severe and simple grandeur in the Doric, with its firm-set columns, its massive triglyphs, and deep entablature; there is a grace in the Ionic, with its more slender

* As the *κοσμητρίαι*, or ornamenters of some deity.

shaft and beautiful volute; there is an elegance combined with rich luxuriance in the Corinthian, with its acanthus capital,—which baffle all theory, which speak to the eye without any explanation being needed on the grounds *why* they should be admired. These remarks, however, affect not the great merit of the treatise I speak of. Lord Aberdeen's work on Grecian architecture is a work which no one should be ignorant of who desires to see the subject handled with scholarship, taste, and discernment.

It is always interesting to know something of the personal appearance, the ordinary address and manners, of the distinguished dead. Lord Aberdeen, though a man of high birth, of public status, of elegant and refined tastes, was to a great degree plain and unpretending in manner. He had, perhaps, a good deal of that cold and reserved demeanour which obtains for the British character, especially for those in high positions, the name of an exclusive, haughty treatment of others. It is often, as in the case of Lord Aberdeen, a most fallacious mark of the real feeling and the true kindness of the heart within. I might have spoken on this point in some measure from my own observation, as I had the honour of personally knowing Lord Aberdeen. But I prefer offering the picture of Lord Aberdeen's personal appearance and manner as they were observed from a different and most impartial point of view,—I mean as they struck the mind of a stranger, and that stranger a visitor from the United States. In the year 1835 a literary gentleman, Mr N. P. Willis, from America, visited this country for the express purpose of writing a tour, which was published in due time under the title of "*Pencillings by the Way*." He had been introduced to the Earl of Dalhousie, father of the late distinguished Marquis of Dalhousie, and was received at Dalhousie Castle, where I met him,—and an acute, unscrupulous observer he was. Lord Dalhousie introduced him to the late Duke of Gordon, and at Gordon Castle he was introduced to the late Lord Aberdeen, of whom he thus writes:—

"Lord Aberdeen has the name of being the proudest and coldest aristocrat of England. It is amusing to see the person who bears such a character.

"He is of the middle height, rather clumsily made, with an address more of sober dignity than of pride or reserve. With a black coat much worn, and always too large for him,—a pair of coarse

check trousers, very ill made,—a waistcoat buttoned up to his throat, and a cravat of the most primitive *negligé*. His aristocracy is certainly not in his dress. His manners are of absolute simplicity, amounting almost to want of style. He crosses his hands behind him and balances on his heels; in conversation, his voice is low and cold, and he seldom smiles. Yet there is a certain benignity in his countenance, and an indefinable superiority and high breeding in his simple address, that would betray his rank after a few minutes' conversation to any shrewd observer. It is only in his manner toward the ladies of the party that he would be *immediately* distinguishable from men of lower rank." (*N. P. Willis' Pencillicking by the Way.*)

Here we find an American tourist brought into contact with the British nobleman, surprised at not finding a man exhibiting all the artificial graces which he had supposed were shadowed forth for all men of rank in England by Chesterfield's Letters; and yet the republican has acuteness enough to discern, under the cold and simple demeanour of the peer, the high estimable qualities of head and heart by which his character was impressed. He feels how much lies beneath, and he is impressed with respect and admiration. He was right in the estimate he formed of him; and further acquaintance would only have deepened the impression of his high qualities. From one who had the first opportunities of judging, I have this testimony, that "he considered him the *best* man he ever knew. That he really believed he was incapable of even comprehending anything mean or ignoble." Such, then, was Lord Aberdeen in his various relations and features of character. He was no ordinary man,—consider him as a statesman or scholar, a man of property, or in his more private relations of life. It is a great blessing when men who are called upon to take so prominent a place in public affairs are really *good* men. The Royal Society of Edinburgh, of which he was a member for years, his family, his country, respect the memory of the late Earl of Aberdeen.

Mr Robert Bell, was son of Benjamin Bell, the celebrated surgeon. He was born in 1782, was educated at the High School of Edinburgh, and was called to the bar in 1809. He must soon have gained some reputation as a lawyer, as he appears in an early caricature of Kay as one of those advocates who pleaded in a wig.

From this period he gradually attained considerable practice. He was made Procurator for the Church of Scotland, and Sheriff of Berwickshire in 1842. Mr Bell had, besides his legal acquirements, a highly cultivated mind. He was fond of mathematical reasoning as a recreation, and did not further apply it. In art he had excellent taste ; and indeed was considered by picture-dealers to have great knowledge of the old Masters, and much tact to discriminate their styles. He made, from his own judgment, a collection of Rembrandt etchings, considered one of the most complete in the kingdom. Mr Bell was a member of the Bannatyne Club, and not an inactive member. He was a great reader, and deeply conversant especially with works on philology. Those who knew him well bear high testimony to his varied powers of conversation, and his skill in discussing and elucidating subjects that were brought forward in society.

A certain George Campbell having injured his property by adherence to his chief, the first Marquis of Argyle, during the trying times of the Covenant in 1662, left the Highlands, and became the proprietor of the estate of Baltulla in the neighbourhood of St Andrews. The great-grandson of that George Campbell was the Rev. Dr George Campbell, for fifty-four years the minister of Cupar-Fife. In 1776, Dr Campbell married Miss Hallyburton, who was connected with some Scottish families of rank, of whom one was Wedderburn, Lord Chancellor. The fruit of this marriage was five daughters and two sons. Of the sons, the elder was Sir G. Campbell of Edenwood ; the second was John Campbell, born at Springfield, near Cupar, September 15, 1781, afterwards destined to rise by his own talents and industry to become a peer of the realm, Chief-Justice of the Queen's Bench, and Lord Chancellor of England. Lord Campbell was always proud of his connection with the Argyle family and with Scotland. He showed this by his kindly and interested allusions to the Campbell clan, which very frequently show themselves in his "*Lives of the Chancellors* ;" and when Lord Chancellor himself he marked his feelings as a Scotchman by thanking most warmly the author of an idle book, called "*Reminiscences of Scottish Life and Character*," when the writer was presented to him, for the great pleasure he had derived from these old stories of a bygone Scottish race. He showed also more decidedly his love for Scotland by purchasing Scottish property, and living in Scotland as much as

he was able. I have observed that in all his publications he is very particular in having F.R.S.E. appended to his name as author.

Lord Campbell was educated at St Andrews, where he was a contemporary of Thomas Chalmers and of David Wilkie; though younger than either, for it appears he entered St Andrews at the precocious age of ten. Young Campbell was intended for the ministry, but he soon found that his calling was not to the Church. His sense of unfitness for clerical studies, joined with ambition to shine at the English bar, led him to London. Mr Sergeant Spankey, then editor of the "Morning Chronicle," gave him employment as reporter and critic. He seemed to have retained his connection with that paper up to 1810, and, what is curious, chiefly as a dramatic critic, writing theatrical articles. Young Campbell showed also at this time that he could claim resemblance to accomplished Roman lawyers, and, for example, to one celebrated by Horace—Asinius Pollio—who was not only a lawyer and statesman, historian, and conversant with the "musa tragœdiæ," but *soldier* also, as Campbell had joined the Bloomsbury and Inns of Court Volunteers, which consisted exclusively of barristers, attorneys, law-students, and clerks. To this circumstance he jocularly referred in after life, in a suit he was trying connected with a volunteer regiment, by saying that he had himself once been a soldier, as a member of the corps, composed as I have said of diverse members of the legal profession, and which he referred to as well known in the capital under the name of *The Devil's Own*. His great object, however, was *law*. He entered as a student of Lincoln's-Inn in 1800, and commenced special pleading under that great master of the art, Mr Tidd, who at one time could point to four pupils of his own sitting in the House of Peers,—Lords Lyndhurst, Denman, Cottenham, Campbell,—all of whom constantly acknowledged their deep obligation to their master. He was called to the bar in 1806, and went the Oxford Circuit, where he soon obtained considerable practice. It was to London business, however, that he looked, and he was soon in great London practice—getting high fees in shipping cases, and in special jury cases at Guildhall. It is well known that in establishing practice for a young lawyer much depends upon the favour with which he is regarded by the attorneys. Lord Campbell in his "Life of Pratt," Chief-Justice of the King's Bench, and father of the Marquis of Camden, says of him, that for eight or nine years his practice did not

improve, because he would not invite the attorneys to dinner, or dance with their daughters. Whether Campbell was a dancing man, or whether he danced with attorneys' daughters, I know not. But it is clear that he took a better and a more lawyer-like plan of gaining the favour of their papas than either dancing or dining. He published a series of Reports of Cases decided at *Nisi Prius* between 1809 and 1816, which was not only in itself very valuable, and established his reputation as a lawyer, but which specially interested the body of solicitors, as the work contained for the first time the names of the attorneys who had got up each case. He had thus very early a great connection with the solicitors, and came into a lucrative and immense business. He soon became leader on the Oxford Circuit. In 1827 he obtained a silk gown. In 1830 he came into Parliament for Stafford. In 1832, was Solicitor-General in the Melbourne Ministry, and was returned to Parliament for Dudley. In 1834, he became Attorney-General on the retirement of Sir William Horne, but lost his seat for Dudley. On Mr Jeffrey's elevation to the Scottish Bench, and consequent retirement from the representation of Edinburgh, Sir John Campbell was returned as one of our city members, and sat till 1841.* Several very important cases in the common law-courts occurred whilst he was Attorney-General, in which he had to take a prominent part. One of his most conspicuous efforts was his defence of Lord Melbourne, the prime-minister, in the action brought by Mr Norton. Campbell's defence was considered so masterly, and the gaining the cause so important to the stability of the administration, that when Campbell entered the House of Commons the evening of the trial, he was generally and loudly cheered by the members on the ministerial side of the House, as a testimony to his skill in managing the case. and his ingenuity in cross-examining the adverse witnesses. At this period many law appointments had to be made, but Sir John Campbell still continued Attorney-General. A purpose of bringing

* Sir John Campbell, whilst a member of the House of Commons, did good service to the country by promoting at all times the cause of legal reforms. He introduced two very important bills which are known by his name. One for the protection of proprietors of newspapers who had inserted libels without malice of purpose, and having made due apologies. The other for the protection of persons against malicious arrest for debts which were not due. The latter arose out of a famous case of arrest, and great hardship, of the Duke of Cadaval on a false affidavit.

him into the House of Peers to assist in deciding appeal cases failed, as did also a plan for making him Chancellor of Ireland. On Lord Plunket's retirement, however, from that office, Sir John Campbell, June 1841, was made a Peer and Chancellor of Ireland. He held the office a very short time, indeed I believe he only sat as judge twice. In the following September, he resigned along with the Melbourne ministry, and for five years lived without office, profession—salary or pension. His mind could not be idle. He took to literary pursuits, and reverted with great zest to the classical studies of his early days. He found, however, the disadvantages of study without object, and accordingly concentrated his attention on a subject congenial with his tastes, and calculated to call forth his powers. He determined to write the Lives of the Chancellors, and of the Chief-Justices of England. The first series of the former was published in 1846, and immediately attained a popularity which has continued to attend both works. When Lord John Russell's cabinet was formed in 1846, it was expected that Lord Campbell would have been Chancellor. He accepted, however, the less important office of Chancellor of the Duchy of Lancaster, with a seat in the cabinet. This did not prevent his pursuing his literary labours; but in 1850 he returned to his more active legal occupations, as, on the resignation of Lord Denman, he became Chief-Justice of the Queen's Bench. It was a trial to succeed Denman, a man of a noble presence, and dignified eloquence. Lord Campbell, without these, carried universal respect by his accurate knowledge of law, his industry, his discretion, and impartiality. In 1859 he became the Chancellor of Lord Palmerston's administration. This was a second trial for him to undergo. Having hitherto been exclusively practised in the administration of common law, it might be expected he would feel embarrassed as presiding in Chancery, and the House of Lords. But his sagacity and his diligence were again triumphant. He lost nothing of the reputation he brought with him from the Queen's Bench. He is said to have been the only Chancellor taken from the common law, in whom it was impossible to detect the slightest embarrassment in the new position to which he was transferred, and amidst the new principles on which he had to adjudicate. His judgments in equity have universally been deemed of the highest authority. It is a striking proof of the activity of Lord Campbell's mind, and his readiness, to occupy

his time and thoughts with questions not immediately connected with his professional occupation, that he should have sustained so long and so important a literary effort, as writing the lives of the Lord Chancellors and Lord Chief-Justices of the Queen's Bench. There is no question of its being a work of great research, great impartiality, and full of acute and able remarks; the stores of information are at once various and minute; the style is far from being polished, but he is always clear and intelligible to his reader; he has done his work thoroughly and well. He happily unites the office of the lawyer and the historian; for the careful law-student of the work will find in the personal history of our Chancellors and Chief-Justices that there is also pervading it a history of our *jurisprudence*. He will trace the gradual establishment of its sounder principles, he will mark the correction of what had been vague or erroneous.

But there is another and a more striking indication of the activity of his mind, and the versatility of his talent, as regards questions which did not come before him as a judge, which is contained in his letter to Mr. Payne Collier, on the Legal Acquirements of Shakspeare. He had glanced at this subject in his "Lives of the Chancellors and Chief-Justices." But in this letter, he brings forward the arguments in favour of an opinion, which had for sometime been gaining ground amongst the admirers of Shakspeare—viz., that before he went to London for his theatrical life, he had been clerk in an attorney's office at Stratford. There are some cotemporary circumstances which seem to lead to this opinion, and these Lord Campbell states in the opening of the letter; but his chief argument is derived from the corroborative evidence supplied by passages selected from his plays. He quotes from twenty-three plays, and he conceives that the passages he quotes give a *probable* evidence that they must have been written by one who had once been a professional lawyer, and familiar with its technical language. I have heard persons speak rather in a depreciating manner of this little production, and who seemed to consider it as unworthy of Lord Campbell, and in fact as in itself of little interest. I am much surprised at this opinion. I think the case is made out in a very ingenious manner; and surely it cannot be a matter devoid of interest to trace back any of the sentiments and expressions of Shakspeare to their original sources, and to analyse the materials of a mind like his. That Shakspeare who drew his imagery and his topics from all sources

in society and in nature, should refer in a general manner to the legal profession, and to lawyers, as a peculiar and marked class of civil life, could have caused no surprise. It would have been quite natural. But when he uses such technical language as can be familiar to professional men only, when his illustrations imply an accurate knowledge of legal principles not generally known, we feel assured that there must be some special cause for materials of such a character being introduced into his writings so frequently and so minutely. It was natural enough, for example, that Shakspeare should say of skilful lawyers, "good counsellors lack no clients," or of lawyers, who are idle in vacation time, that they "sleep between term and term," or that he should call time "the common arbitrator." That Gratiano would propose for Shylock, besides his two godfathers, when he became a Christian, *ten more*, meaning that he would have him before a jury to be tried for an attempt to murder Bassanio; or that the fool in Lear should say that the maxims which the old king declared were "nothing," were like "the breath of an unfeed lawyer, given to the king for nothing," and many other examples. But it is very different when he uses terms and makes representations, which imply a knowledge of nice points of law, and points not generally known, except by professional men. As, for instance, in the "*Merry Wives of Windsor*," Ford says, that "his love was like a fair house, built upon another man's ground, so that he had lost his edifice by mistaking the place where he erected it," showing that Shakspeare had a knowledge of real property not generally possessed,—viz., the knowledge of that maxim of lawyers applicable to land: "*cujus est solum, ejus est usque ad cœlum*," under which any house erected on a freehold becomes the absolute property of the soil,—so that the luckless builder cannot remove any of the most costly adjuncts of his building, such as the finely-carved chimney-pieces, or expensive marble pillars, with which he may have adorned the edifice. A passage in the "*Comedy of Errors*" draws out a most circumstantial and graphic account of what is called in English law "*Arrest on Mesne Process in an action on the case*." No one could have adopted the phraseology in the conversation between Adriano and Dromio, who had not a technical acquaintance with the point of law so named. It is very curious also, that Shakspeare, in the grave-diggers' scene, where he speaks in a ludicrous tone of "*Crowner's Quest Law*,"—i. e., the law as laid down by a coroner when he holds an inquest on

a dead body—should show his intimate knowledge of a celebrated case of *felo de se*, tried in the reign of Philip and Mary before a coroner, and which was afterwards brought into the higher courts. The case had been reported by the famous Plowden, and Shakspeare evidently intended to ridicule the counsel who argued, and the judge who decided it. Hamlet's own speech quotes a string of technicalities, with the meaning of which the author is apparently familiar,—such as speaking of a lawyer's recognisances, his fines, his double vouchers, his recoveries, and of these vouchers, whether single or double, vouching him no more of his purchases than a pair of indentures,—and of which Lord Campbell declares that it would puzzle practising barristers of his acquaintance to define each satisfactorily; and let it be remembered, that Lord Campbell quotes upwards of sixty examples of such law passages more or less to the point. Whether Shakspeare were or were not trained in an attorney's office can never now be known beyond conjecture, but the book shows Lord Campbell's ingenuity, and his readiness on a question of law and literature in curious combination.

Such is a brief sketch of the active and varied life of John Lord Campbell. He was assuredly a very able man, and has achieved a name in his country's annals which will not pass away. The leading characteristic of his mind, as I have always heard from those who knew him best, was *determination*—a firm resolve to accomplish his object before him, and to attain the highest place in the path he had set himself to pursue. His efforts were successful, and he never relaxed in his diligence, never swerved from duty. A little incident will illustrate this adherence to what he considered was incumbent on him to accomplish, at all risks to his own personal convenience. When the naval review took place at Portsmouth, in 1853, the nobility and leading commoners of the empire were to attend, and a steamer was appointed to convey the whole House of Lords from Southampton, and to bring them back to the same point when the review was done. They were obliged to start from London, the day of the review, at four in the morning. One mishap succeeded another, so that the party did not reach Southampton till three the following morning, and were not in London till six. Notwithstanding all the fatigue and delay of so long an expedition, Lord Campbell, then Chief-Justice of the Queen's Bench, was enabled to state in the House of Lords, with great complacency, when com-

plaints were made of the bad arrangement of the expedition, that the suitors had not suffered from the mismanagement, as he had taken his seat in Queen's Bench at the usual hour, half-past nine. He was then seventy-two.

Lord Campbell owed his success in life entirely to his own exertions, and his own innate powers of mind. He had not those external accessories of address or grace to which men are sometimes indebted for much of their success, and from which they gain artificial advantage in the public eye and estimation. He was plain, in his exterior, nor had he a polished style of writing or of speaking. He had nothing of what is usually termed eloquence, and yet all he said and wrote *told* and produced good effect. Like Lord Aberdeen, he enjoyed in his lifetime the respect and consideration due to his talents and his success, but which are posthumous to so many good and able men. For him a cotemporary might very properly use the address made to Augustus, "*Presenti tibi maturos largiamur honores.*"

Lord Campbell never felt what so many able men feel before they have to give up their place in this world,—viz., that "*multa senem circumveniunt incommoda.*" He had only *one* of those two seasons of childhood which Shakspeare has assigned to every human being, nor could he ever have said with Lear :—

"Infirmity doth still neglect all office,
To which our *health* is bound."

He died in his eightieth year, in the midst of full occupation as a statesman and a judge, and with faculties, I believe, quite unimpaired. Few men can hope ever to attain Lord Campbell's eminence; few can expect to reach his years without infirmity and decay of mental and bodily faculties. But all may imitate his example in the fixed determination to do their utmost in the path which Providence has assigned to them, and all may follow him in the full resolve faithfully and honestly to discharge every duty for which they have become responsible.*

John Gordon, Esq. of Cairnbulg, who died during the present

* Those who best knew Lord Campbell in *private* life bear testimony to his amiable and affectionate deportment in the domestic circle. To his habitual unselfishness, which made him seek the comfort and happiness of every one before his own, and to the freshness and simplicity with which he enjoyed, with young people especially, the few simple pleasures for which his immense labours left him time.

year at an advanced age, had long been a Fellow of the Royal Society. He spent many years in Edinburgh, and at one time was in some practice as an advocate. I recollect him a regular attendant on the Society's meetings. But his natural bent was towards the duties and avocations of a country gentleman. These occupied his attention during the later years of his life. But he joined, with all his pursuits, a love of literature to the last, and, with much intelligence, took great interest in everything that was going on at home or abroad in the fields of scientific and literary inquiry.

John Schank More was born at North Shields in 1784, where his father was the respected pastor of a congregation in connection with the first seceders from the Scottish Established Church. He was educated in Edinburgh, and had an early predilection for the bar, to which he was called in 1806. He had good practice as a junior counsel, but he soon showed that his bent was rather to the teaching of the profession, and the exposition of the general principles of law as its expounder, than to the practice of court. In 1827 he published an edition of "*Erskine's Principles of the Law of Scotland*," a very useful manual for guiding young students to a correct knowledge of that standard manual. But in 1832 he published his most important work, his edition of Lord Stair's "*Institutions of the Law of Scotland, with Notes and Illustrations*." Lord Stair's work was the production of a most philosophical mind, as well as of a profound lawyer. It contains more than a digest of municipal law, it contains an able treatise of general jurisprudence. His illustration of such a work, therefore, fell in with Professor More's peculiar habits of mind and thought. I have been assured by an eminent Scottish lawyer, that he was particularly happy in bringing forward all circumstances in illustration of his abstract law principles, whether derived from home or foreign sources. He had extraordinary knowledge of what may be termed the *literature* of the law. Hence his edition of Stair has taken its place as a standard work, and is quoted for general principles, both at the bar in argument, and on the bench in judgment. A course of study producing such happy results as the Professor's labours in the two great works of Erskine and Stair must have been recognised as the best preparation for a legal chair, and the best proof of fitness for its occupancy. Accordingly, in 1843, on

the death of Professor John Joseph Bell, he succeeded to the chair of Scots Law in the University of Edinburgh. It would be unbecoming, in one not a lawyer, to pretend giving a judgment on the merits of a professor's teaching of law. But that he performed his work under a solemn sense of duty—that he spared no pains to make his class understand the principles and the details of a science which he had diligently and successfully studied himself, is a matter of general notoriety, and the public papers, at the time of his death, all bore testimony to his merits as a professor. One feature of his professional work was very remarkable, and attested by every hard-working student, I mean the unwearied pains he took in going over their papers, and the careful manner in which he corrected the essays sent in to him. There may be something animating and attractive in looking over the exercises and theses of Scots law students, I am unable to judge of this, but I should think, in general, such examinations must be a dreary portion of any professor's labours. But Professor More never seemed to weary. He never intermitted his care, and seemed always fresh for doing, and doing kindly, what he considered an act of duty by his pupils. Professor More, in fact, made his studies, and everything connected with his profession, a part of his daily and ordinary life. He enjoyed books, because he made good use of them, and he had collected a library of upwards of 15,000 volumes. These books were his delight—his companions in solitude, his comfort in the tedium of hours of sickness. He could turn at once to the volume he wanted, and to the passage he desired to recall. When I say his books were his companions, I might rather have said the *authors* were his companions. In a letter to one of his family, shortly before his death, he draws in himself a pleasing picture of an old man in his study surrounded by his books, and holding converse with his favourite authors:—

“While reading Leighton quietly in my own room, it struck me that the old man was really sitting with me, and conversing familiarly upon those topics which so entirely engrossed his own mind; and it is a curious reflection that, with such books, I have been conversing as truly with Horsley, Hooker, and Leighton as if they had risen from their graves and sat by me.”

Whilst I remark the Professor's liberality of feeling in naming as his favourites three authors who were *not* members of his own Church, I think my hearers will excuse some personal feelings of

pride and satisfaction in observing that Leighton, Horsley, and Hooker are ornaments of my own Church.

There is a circumstance connected with the late Professor's library which was so peculiar that I cannot resist referring to it. He was a most indefatigable collector of PAMPHLETS, and formed the largest collection of a private individual, I believe, in Scotland; and it is always curious to notice what any man has done different from other men. Some years ago I had the honour of reading before this Society a memoir of my illustrious friend Dr Chalmers. Professor More heard of my intention, and very kindly offered me the use of a volume, which he had collected, of sermons, memoirs, poems, &c., all relating to Dr Chalmers. I found this one of a series of volumes of collected fugitive pieces, then amounting to 700 or 800; but which, before he died, the Professor had raised to the number of 1400 volumes,—that is, about 14,000 pamphlets. It would be desirable that the volumes should be purchased unbroken for some public library. Such collections are very valuable for reference. Single pamphlets, lying loose in a library, are a regular nuisance, and most troublesome, always getting in the way; but if you look for any particular pamphlet you never find it. Pamphlets, however, when formed into such a collection as this, are a very different matter, and may, as I have said, be extremely valuable, as affording to future students of history very important information on cotemporary circumstances, which is sometimes not otherwise to be obtained; and for this reason some rare and curious pamphlets have been sold for enormous prices, and are much coveted by collectors. One of the most curious historical collections of pamphlets in this kingdom is that in the British Museum, which was presented in 1763, by George III., to the library of that gigantic institution. It was made by a royalist bookseller, named George Thomson, during the Commonwealth. It consists of 2220 volumes, and contains about 34,000 pamphlets, nearly all of which refer to the civil wars, and to the affairs of the country between 1640 and 1661. To show the comparative extent of Professor More's collection by a private individual, as compared with public collections, I may note here that the Edinburgh Subscription Library is advertised to contain 600 volumes, or about 1600 pamphlets; the Signet Library contains about 5000 pamphlets; the College Library about 25,000; and the Advocates Library near 67,000 pamphlets, or 3649 volumes. In catalogues

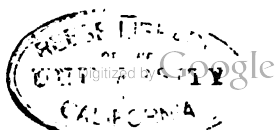
of books, such as Dr Parr's "*Bibliotheca Parriana*," and other celebrated sale catalogues, there is generally a pretty copious account of the rarer tracts and pamphlets contained in the collection to which the catalogue belongs. But there is a *history* of pamphlets, which is one of the most extraordinary books in the English language, published in London 1715,—a book well known to librarians and collectors. The author was Myles Davies, who seems to have been odd and eccentric to the last degree. He was very poor, and wrote for bread; very learned and of great research, but his style rambling and grotesque. The work, in six volumes, is very scarce, indeed. it is esteemed amongst the rarest books in bibliography, and is entitled, *Εικων μικρο-βιβλικη*—"Sive Icon Libellorum," (what we should call in Scotch "little bookies,") or a critical history of pamphlets, &c. &c. In a long, rambling preface, he enters upon a history of pamphlets, and describes their different uses and qualities. He very coolly says in the preface:—"We need not go farther back than 2000 years *before* the creation of the world." Some Jewish rabbins having profanely asserted that heaven itself had at that time written the small volume containing the synagogue rule of their law; and he quotes Saldenus, a Dutch divine, who, in the first of forty-one erudite dissertations (Amsterdam, 1684), combats the rabbinical opinion, that Adam and each of the patriarchs had written a pamphlet. Davies dedicates the sixth volume of his history of pamphlets to his patron, Dr Crowe, and addresses him in this complimentary strain in a Latin poem, commencing,—

"O corve, corvo rarior albido!"

In all the intercourse of private life, and all domestic and social relations, nothing could be more exemplary than the conduct and demeanour of Professor More. There was a gentleness of disposition which seemed to shrink from doing an unkind action, or saying a harsh word to any human being. He had that large-hearted feeling for mankind which could not withhold from others the mercy he expected for himself, and which would never deny encouragement to the most erring when making promises of amendment. I recollect his saying, with a charming simplicity of character, that he thought people were quite right to attend the lectures which Lolla Montes was delivering here at the time, as they proved that now she designed to turn over a new leaf, and to earn an honest livelihood! I have spoken of the pains which he took with his class. He was

forbearing and patient with those who were idle or inconsiderate. When thoughtless or ungenerous members of the class would (as young men sometimes will) forget themselves, and take those liberties which are so unbecoming in the gentleman and the student, the kind-hearted teacher hardly gave indication that they were even noticed by him. He might be occasionally grieved or pained, but was never irritated. I have often thought it is good to have known such characters as John Schank More,—not, mark me, on account of great accomplishments, high genius, or profound learning, but because they put one in better humour with the world, and make one think better of human nature, as living illustrations of the great and pure principle of Christian love, and as exhibiting in their lives and dispositions a rare resemblance to the spirit of Him whose name we all bear. Let such men be held in honour by their cotemporaries, and let their survivors cherish their names with grateful remembrance, as true benefactors of their species, who have shown to the world, in characters which cannot be mistaken, the power and beauty of Christian gentleness.

Sir James Miles Riddell, Bart. of Strontian and Ardnamurchan, who died 28th September 1861, at the age of seventy-four, was long a Fellow of the Society, and at one time took much interest in its proceedings. He was beloved and esteemed by all his friends as a man of most amiable disposition, and honourable character, through life. Although Sir James could not be called a scientific man, in so far as special study of any branch of natural science was concerned, yet his name is associated, as a landed proprietor of Scotland, with an important mineralogical discovery. One of the earths was found on his property from which it is named, and as this mineral was first discovered by a Scotchman, and from the beginning has borne a Scottish name, I may perhaps be allowed to say a few words on the subject in passing. In 1787 some minerals were brought to Edinburgh by a dealer from Strontian, Sir James Riddell's property in Argyleshire. They were examined by Dr Hope, then the eminent Professor of Chemistry in the University. In 1791, Dr Hope announced, in a paper read to the Society, that in one of these minerals he had detected a new earth, and which he proposed to name Strontites, from the locality from whence it was received. It seems previously to have been confounded with barytes, and sup-



posed to be some modification of that substance. The paper was more fully elaborated, and published in the "*Society's Transactions*" 1793. The German chemist, Klaproth, had also examined the Strontian mineral, and without any knowledge of Dr Hope's experiment, had also discovered in it the new earth, and called it "Strontion." According to our present nomenclature, the earth is called Strontia—the metal which forms the basis of the earth is Strontium, and was separated and exhibited by Sir Humphrey Davy. The native mineral from Strontian which produced the earth is called Strontianite, and is a carbonate of Strontia. It has been found also at Braundsdorf in Saxony, and elsewhere. There are other native minerals of which Strontia forms the basis, one called Celestine, so named from the beautiful blue tinge of its crystals. I have seen lovely specimens of Celestine from the Mountain Limestone quarries near Bristol. Finer specimens are, however, met with in the sulphur mines of Sicily, and still finer in the Strontian island in Lake Erie. When it was known that a new earth had been discovered in the Strontian district, the proprietor and all concerned were full of expectations of benefits which might accrue from the discovery of a substance of which they were supposed to possess a monopoly. But, alas! no use has been found for it in the arts or manufactures—none at least of what may be called particularly beneficial. The only application has been in the form of nitrate of strontia, and which is made use of to produce that beautiful red light which is exhibited in fire works, and also in certain pantomimic and melodramatic effects in theatrical representations, which delight the children who attend, both young and old.

Dr James Robertson, was born in 1803, at Ardlaw, in the parish of Old Pitsligo. His father a farmer at Ardlaw, still survives at the advanced age of eighty-six. Dr Robertson completed his education at Marischal College, Aberdeen, and his first appointment in life was to the parochial school of his native place. He was soon after appointed head-master of Gordon's Hospital in Aberdeen. In 1832 he was appointed to the living of Ellon, in the gift of the Earl of Aberdeen, and was long familiarly known, as a powerful debater in the General Assembly, as Robertson of Ellon. In 1843 he was called to the Chair of Church History in the University of Edinburgh, and Secretaryship of the Bible Board, and which situations

he held till his death, which took place unexpectedly, and after a very short illness, 2d December 1860. Dr Robertson was a man of acute mind and sound judgment, a fluent speaker, and of energy indomitable. I have always considered Dr Robertson an admirable specimen of the acute, clear-headed, business-like Scottish character. His pursuits and labours were all of a useful and practical character. The conduct of ecclesiastical affairs of the Church, general parochial management, the study of Church History for his lectures—everything connected with the poor and administration of the poor-laws, agricultural improvement of soils, and the currency question, were subjects closely and skilfully investigated by him. When parochial schoolmaster, he wrote a pamphlet “On the Currency,” which attracted the attention of Lord Aberdeen, and which, in fact, led to his appointing him to the incumbency of the living of Ellon. There existed through their lives a friendship and sincere mutual regard, and these continued to their deaths, which happened within a few days of each other. Dr Robertson died on 2d December, Lord Aberdeen died on the 14th, 1860.

Dr Robertson was through life much interested in the currency question, and read a very elaborate paper on the subject, at Glasgow, during the meeting of the Association for the Advancement of Social Science, which was held in that city during last year. Some time before this I was much interested in hearing him brought out upon this question, on the occasion of his dining with me, when he met my dear friend, the late Alexander Blair of the Bank of Scotland, a man of highly cultivated mind, and of great attainments in theology, in classical and general literature—the first authority in Scotland upon banking, upon the currency, and indeed upon every subject connected with finance and the circulating medium. It was very amusing to hear the discussion between two such men—one all theory, the other bringing every theory to practice; the one arguing from the conclusions of an acute intellect, the other, from long and accurate experience of banking, and of everything belonging to it, and who well knew that every opinion in money matters, however ingeniously supported, must be brought to the test of experience in the working of it under all the circumstances of the social and monetary system.

The memory of Dr Robertson will ever be preserved in Scotland as connected with that great scheme of church extension with which

his name is now always associated, and which owed so much of its success to his labours and his wisdom. The intention of the scheme is to create and endow above sixty new parishes in connection with the Established Church. He was mainly instrumental in raising, by immediate or by deferred payments, for this great object, a sum of nearly half a million; and on this portion of his life I am anxious to say a few words, and I do so not only because it called forth a marked feature of his own character, and because it indicated a special power of his own mind, but because I conceive it affords a most useful *general* lesson, and supplies an honourable example for all men who are engaged in practical work, and who have to aid in plans of advancing the interests of religion, of charity, or of any improvement in social life. I refer to his labours as secretary, or convener, in which he practically advanced the details of that object of which I have made mention. The scheme was most important, and in every way praiseworthy. It called upon the members of the Established Church to join in a great and well-organised scheme for church extension. I need not dwell upon the particular constitution of the plan, the special object it placed before the community, or the special means it had in view for attaining those objects. What I wish now mainly to notice is the manner in which our late member worked the machinery of the scheme,—the diligence he displayed—the cool, yet earnest decision with which that diligence was accompanied. I would refer to his clear and powerful statements of the case he advocated; I would point to his never-failing attendance at meetings throughout the country, his constant readiness to avail himself of all advantages, to meet all deficiencies, and to correct all mistakes. His labours never seemed to be at rest; his sagacity was never at fault. It was such qualities advanced into full action that, under the favour of God's approval, brought the scheme to its present condition of efficiency, and opened its prospect of ultimate success. What I would mark out and recommend for approval and imitation, are those very exertions by which the efficiency of the scheme was promoted. Dr Robertson was a man of business, and such men are wanted amongst us,—wanted because they are scarce, and wanted because they are valuable. In vain will you have men of learning, eloquence, or acuteness upon your committees in great associations for advancing good purposes: if you have not men of *business*, the schemes will fall to the ground, or languish and decay. *Experto crede*. I have some little experience of such matters my-

self. Committees meet and questions are discussed, and faults are found, and measures proposed and adopted, and a great deal of acuteness and eloquence are displayed,—sometimes, perhaps, a little temper and vituperation. The committee separate, the matter sleeps, and, except some one takes it up vigorously to work it out in detail, the committee, at next meeting, find matters much in the same position as they were when they last parted. Now, all this *intermediate* labour was supplied by Dr Robertson; he set himself to the work,—he would not permit the matter to sleep,—he pushed forward the scheme,—and to the last moment of his being able to hold the plough, did not look back from his good work. He determined that his countrymen should support his scheme; and the call of the Roman poet to the Roman people in many ways typified the call of the Scottish divine to the Scottish landowner, or wealthy merchant, “*Delicta majorum immeritus lues, donec templa reficeris.*”

Such was Dr Robertson. A man of the best intellectual and active habits, who brought his understanding and his activity to bear successfully on a great and noble scheme of national benefit. He was cut off at a comparatively early age, at least whilst still capable of much useful labour; but he was followed to the grave with the respect and honour of all his countrymen, whatever were their political opinions, whatever were their religious creed.

One name only remains on our list of deceased members, that of Erskine Douglas Sandford, advocate, and Sheriff of the Stewartry of Kirkcudbright and County of Galloway. He was born in 1793. He was eldest son of Dr Daniel Sandford in the Scottish Episcopal Church, Bishop of Edinburgh. Bishop Sandford was from an old family of Shropshire. But he formed a Scottish connection by marriage. Erskine Sandford was born in Edinburgh. He had become completely in feeling and connections a Scotchman, and at one time was in good practice and high reputation as an advocate, and a writer upon law. It encroaches, perhaps, too much on the offices of private friendship for me to say much upon the character of this our late Fellow. But I may appeal to the *general* feeling that pervaded the circle of Edinburgh society when the unexpected intelligence came of his death; every testimony was given to his character, as a man and as a Christian, and every sympathy shown to his family in the loss which by his death they had sustained.

Gentlemen,—I have now accomplished, however imperfectly, the objects which I had before me in this Address,—viz., 1st, To notice the influence exercised generally by learned associations upon the advancement and extension of literature and natural science; and, 2d, To take a brief notice of certain members of the Royal Society of Edinburgh who have died since the opening of the late Session.

Nothing more forcibly brings before us the advancement of mankind in mental improvement and in mechanical refinement than the power which we possess of realising the past, and of storing up the discoveries and the disquisitions which have been made by those who have preceded us. Human knowledge seems now to be all recorded for the benefit of posterity. There is such a multiplication of books, and such economy in the production of books, as to make that knowledge available to all ranks of society. There is an arrangement and classification of books according to the subjects of which they treat which prevent libraries becoming a hopeless labyrinth—an overwhelming incubus. The achievements of able and original minds are preserved by those who have possessed kindred spirits with their own, and none of their labours need be lost,—nothing that they have accomplished need perish. I think our scientific societies have had a great and extensive influence in producing these results. That spirit of combination and companionship which has worked such numerous and permanent effects in all departments of human life, and which is an innate principle of human nature, has operated in combining men for objects which may be good or may be bad. Whilst we see with pain and grief the union of human beings accomplished for the express *purpose* of evil, and for injuring others in order to promote the advantage of those who unite, it is delightful to think how close, also, combinations may be made for the improvement of the species, for advancing knowledge, either exclusively in one of its departments, or generally in every department. Men combine together in associations for amusement, for recreation, or for gaiety. They combine together for purposes of pecuniary profit, to secure political ascendancy, or more refined educational benefits for their families. This spirit of combination has produced also many associations like our own; around the labours and the operations of these there has gathered an accumulated history of genius and discovery, which must be enduring as the human species itself. The highest place in our veneration and esteem is, no doubt, due to

those sacred associations which are formed under a religious spirit of union, either for disseminating the Word of God in all the languages spoken by the numerous families of human beings throughout the world, or for promoting the spread of Christian knowledge, whether amongst the neglected outcasts of our home population, or amongst the heathen who have never heard a Saviour's name. But next to these we may venerate and esteem the associations which unite men for the cause of sound philosophy, and for advancing all branches of useful human learning, which draw men together for literary and scientific purposes, and which impart to them a common interest in the discovery and extension of truth. We cannot fail to perceive the merit of associations which thus unite men of very different habits and occupations in the encouragement of all those pursuits which, as long experience has now proved, tend to ennoble man's nature, and to elevate his sources of enjoyment.

REVIEWS AND NOTICES OF BOOKS.

Report of the Commissioners appointed to Inquire into the Condition and Management of Lights, Buoys, and Beacons, with Appendix. Presented to both Houses of Parliament by command of her Majesty. London, 1861.

Memorial of the Chamber of Commerce and Manufactures of Edinburgh (Incorporated, by Royal Charter) to the Board of Council for Trade, &c. 1861.

To a sea-girt and truly maritime country like ours, it is not easy to conceive anything more important than the efficiency of its lighthouse system. To promote this object, a Royal Commission was in 1858 appointed, consisting of Rear-Admiral Hamilton, Captain Ryder, R.N., Dr J. H. Gladstone, Duncan Dunbar, Esq., M.P., and Samuel R. Graves, Esq., who conjoined with them the Astronomer-Royal, to inquire into and report on the whole subject. The report of this Commission, which was laid before the last session of Parliament, gives a review of the lighthouses of nearly the whole world. The Commissioners personally inspected most of the lighthouses of the United Kingdom and France, and have been upwards of two years engaged in the inquiry. We were quite prepared to find that a country that has produced such works as Smeaton's Eddystone, Stevenson's Bell Rock, Walker's Bishop Rock, and Alan Stevenson's Skerryvore, should stand high in the annals of lighthouse engineering, and

we were not mistaken. From what we can learn from a careful perusal of the report, the efficiency of our lighthouses, more especially those in Scotland, is not surpassed by those of any quarter of the world.

The lighthouses of the United Kingdom are, as our readers are no doubt aware, placed under the management of three separate Boards, namely, the English under the Trinity-House of London, the Scotch under the Commissioners of Northern Lights at Edinburgh, and the Irish under the Ballast Board at Dublin. The Merchant Shipping Act of 1854 enacted that the Commissioners of Northern Lighthouses and the Ballast Board should report to, and receive the sanction of the Trinity-House as regards the sites of all new lights, and that the whole three Boards should, in all matters regarding the selection of sites and expenditure of funds, report to, and secure the sanction of the Board of Trade. This divided responsibility seems to have led, in some cases, to much unnecessary correspondence; and the result of the Commissioners' recommendation is, that while commending, in some respects, the management of all the three Boards, but especially that of the Commissioners of Northern Lighthouses, they recommend the formation of a central Board, to be called the "Trinity Commissioners for Lights," to consist of four members resident in London, one in Edinburgh, and one in Dublin, and a seventh to be selected by Government, "with special reference to his scientific acquirements in these branches of knowledge which relate to coast illumination." To these, it is proposed to add, as *ex officio* members, "the Astronomer-Royal, the Hydrographer of the Admiralty, the Comptroller-General of the Coast-Guard, and one of the professional members of the Board of Trade."

In making this recommendation, it appears to us, that independently altogether of the injustice which it does to the Commissioners of Northern Lighthouses, the Royal Commissioners have allowed themselves to be actuated more by the general vague feeling that *centralisation* is the panacea for all evils, *fancied* or *real*, than by any positive objections to the existing lights, or by any conviction of the practicability of their own involved and cumbrous proposal for managing them. Before Government adopts such a recommendation, it would surely be wise to see whether the remedy which it proposes be applied in the right quarter, and whether all that is wanted in the shape of improvement cannot be attained by alterations on the constitution of some of the existing Boards. It appears to us self-evident from the report itself, that the Northern-Lighthouse Board has satisfactorily and efficiently discharged its duties, and that, had the Commission found the English and Irish as fully up to the mark as the Scotch admittedly are, they would have had nothing to recommend; and yet it is strangely enough proposed to supersede the Scotch Board.

Now, the question not unnaturally occurs, Would it not be more appropriate, as well as a more just course, to propose that the English and Irish Boards should adopt the Scotch system? In support of what we have now stated, we give the following quotations from the Report, in which the superiority of the Scottish Lights seems to us to be clearly demonstrated and admitted.

As regards the "Character of the Source of Light," the Commissioners say—"To the subject of the height of the flame, your Commissioners have given much consideration." . . . "The flame in English and Irish Lights is kept far too low." . . . "This fault was not found to exist in the lights under the Northern Commissioners, who make use of a mechanical pump-lamp, which burns, on an average, 794 gallons of oil annually, and produces good flames of about double the height of those in England or Ireland." . . . "From this it is evident, at a glance, that as the Scotch dioptric lights burn a larger amount of oil than the English or Irish, they are more expensive in that item; but in this particular, expense becomes a measure of efficiency." . . .

Under the head of "Character of Apparatus by which the Light is Directed," it is stated—"There are two principal means by which it is sought to throw the light in the desired direction. The one is by silvered parabolic reflectors, and is called the 'Catoptric' system, the other is by lenses of peculiar construction, and is called the 'Dioptric' system. Sometimes the two systems are combined together, as in the ordinary 'Catadioptric,' and in Mr (Thomas) Stevenson's 'Holophotal' arrangement. The table already given (page 15) shows the proportion between the catoptric and dioptric lights at present existing in the three kingdoms. It will be seen that the principle of refraction is generally adopted in Scotland, while that of reflection still holds the numerical preponderance in England and Ireland." . . . "As to the optical apparatus, the dioptric system,* invented and first employed in France, has been gradually adopted in our own country, and in Scotland some improvements have been made in it." . . . "Few will doubt that a combination of the two" (dioptric and catoptric) "would often be the most efficient; and such combinations exist in all countries, but especially in Scotland."

On the subject of the "Quality Compared with Foreign Lights," the Commissioners say:—"The quality of British lights (speaking generally) is equal to the quality of lights in any part of the world." "The fixed catoptric lights of the British Isles," it is stated, "will not bear comparison with revolving lights on the same principle, or with the dioptric lights of France or Scotland."

* It may be interesting to our readers to see the conclusion to which the Commissioners have come as to the origin of the lenticular system, which has been the subject of some discussion in this country.

Under a head termed "General Authorities," the Commissioners say: "The Trinity House has consulted Professor Faraday, as its scientific adviser, since 1836; but it appears that he only gives his opinion or advice on such subjects as are submitted to him. The Northern Commissioners have had the great advantage of having associated with them the family of the Stevensons, who have given much attention to those departments of science which relate to lighthouse illumination."

"As a test of the degree of scientific knowledge exhibited by the different lighthouse authorities, your Commissioners asked for copies of the plans, specifications, &c., actually submitted to the manufacturers, in ordering the last two sets of lenticular apparatus of large size or peculiar form. The resulting correspondence is given in vol. i. p. 210, with an account of the different practice of the four principal lighthouse authorities, viz., the Board of Trade, the English, Scotch, and Irish Boards. From this it appears that, in Ireland, forms of tender are issued, 'setting forth the arc intended to be illuminated, the number of panels and zones required, and the apparatus shall be of the best quality, and fitted together correctly;' in England, printed forms and lithographed drawings of small size are furnished to the contractors; while in Scotland, large working drawings and minute directions are given by the engineers employed by the governing authority for the execution of apparatus specially designed by them for special localities.

"In the case of the English and Irish Boards, the governing body does not originate the design. In Scotland, a design is furnished by the governing body, and the manufacturer has only to execute the order given.

"The latter arrangement seems calculated to produce an advance in science."

"Here, then, seems to be a defect in the system of management." . . . "When they employ men who have made these particular branches of knowledge their study, the result is good. The Commissioners of Northern Lighthouses have, in this respect, shown themselves considerably in advance of the Elder Brethren of the Trinity House, by employing an engineer who has studied lighthouse illumination, and claims to have invented or introduced many improvements into optical apparatus, to prepare specifications for scientific work. The result of the opposite course adopted by the Trinity House is shown in the defects observed at Godrevy, the Start, the North and South Foreland, Whitby, &c."

In the section headed "Efficiency and Economy of Government," the following statements appear:—

"Generally, to inspect the minor arrangements of one lighthouse in Scotland is equivalent to having seen them all; for the only variety seems to be in the illuminating apparatus, which in very

many instances is specially designed for the locality, and has to be separately examined before it can be fully understood ; while in England, the uniformity is rather to be found in the illuminating apparatus than the minor details of the service, which vary in different lighthouses. In Ireland, not only is there a great want of uniformity as to the minor details, but they seem to be very much overlooked and neglected, while the apparatus is about equal to that of the Trinity House."

"In Scotland, as in France, a drawing of the flame, as it ought to be when at its best, is framed and glazed, and hangs in every light-room ; this is not to be found in England or Ireland.

"In Scotland alone a table of the time for lighting and extinguishing is hung up in the light-room. These times differ for every latitude, and are carefully calculated for each lighthouse in Scotland, and the result is, as before stated, a considerable economy.

"In Scotland, whistles are placed in every lantern, which communicate with the rooms below by tubes, in order to summon assistance, if required, and to avoid the necessity of the keeper in charge leaving his post until relieved. There are no communicating whistles in England, or Ireland, or in France."

... "In Scotland, the keepers go through a regular course of instruction and training as extra-keepers at lighthouse stations, where dioptric and catoptric apparatus exist, and have to pass an examination before they are intrusted with the care of a light. In England, a preliminary course of instruction is gone through at the Trinity Board's Establishment at Blackwall ; and in Ireland there is no such system of instruction—certain questions only being put to the candidate on his presenting himself."

"All these points influence the *efficiency* of the lights ; and there can be no doubt that of all the British lighthouses visited by your Commissioners, the Scotch are in the best state of general efficiency, the English next, and the Irish third ; and the local authorities, with certain exceptions, range far below the general authorities."

The statement of the Commissioners, "that the quality of British lights (speaking generally) is equal to the quality of lights in any part of the world," coupled with the further statement that there can be no doubt that of all the British lighthouses the Scotch are the best, leads to the conclusion that the lighthouses under the Commissioners of Northern Lighthouses are, on the whole, better than any they had seen. This is confirmed by the Astronomer-Royal, Mr Airy, who, in his Report to the Commission on his examination of Girdleness, in Aberdeenshire, after having inspected the Lighthouses of France and England, says of Girdleness, "It is the best Lighthouse I have seen."

We beg to refer such of our readers as may wish to see further details, to the Report itself, which is a very voluminous one.

We cordially concur in the conclusions of the Chamber of Commerce of Edinburgh in their Memorial to the Board of Trade in reference to the Report quoted at the beginning of this article, which are in the following terms :—

“ After careful consideration of the Report by the Commissioners, it humbly appears to the Chamber that the only conclusions which can be come to are :—

“ 1. That it would seriously injure the public service were any change agreed to which would abolish the present Board of Northern Lights, which, from its compound constitution, embracing at once high official rank and commercial experience, has brought the Northern Lighthouses to their present state of efficiency.

“ 2. That any conflict between the separate Boards, as at present, would be obviated by each Board being restricted to local management, subject to the immediate control of the Board of Trade.

“ 3. That the admittedly efficient system of management of the Scotch Lighthouses could, without any radical change, be easily and at once adopted by the existing Boards of Management in London and Dublin.”

Medical Climatology; or, A Topographical and Meteorological Description of the Localities resorted to in Winter and Summer by Invalids of various Classes both at Home and Abroad. By R. E. SCORESBY-JACKSON, M.D., F.R.S.E. Churchhill: London, 1862. 8vo, pp. 509.

Climate is a subject of great interest and importance, whether we regard its bearing on the distribution of plants and animals, or on the wellbeing of the human race. The determination of the elements of climate is a matter of much difficulty. Light, heat, and electricity, moisture and dryness, the movements of the atmosphere, and its weight and composition, the nature of the soil, the relation between land and water, the influence of the sea, the elevation above its level, the flat or mountainous character of a country, the vegetation, especially the forests, and a multitude of other data, require to be taken into account before we can form proper conclusions as to climate.

Dr Jackson defines climate as the sum of all those physical forces which, by their operation upon the constitutions of organised beings, prohibit their permanent migration from one region of the earth's surface to another. He then proceeds to say—“ But man, it may be said, in objection to such an interpretation of the word—man, at all events, is cosmopolite; he can go everywhere and live anywhere! It is true that the erect and intellectual

being who received at the hands of his Maker dominion over all precreated subjects, and to whose necessities all meaner creatures subserve, is endowed with a constitution of such a character as enables him to violate the laws of climate with apparent impunity, and to journey hither and thither in his military, commercial, or scientific capacity, according to the impulse of his will. We know that the inhabitants of temperate climates have passed prolonged seasons in foreign countries whose annual mean temperature is widely different from that of their native land. What better proof can be adduced of the perfect possibility of doing so than the facts that our own brave soldiers have fought and conquered beneath a broiling Indian sun, whilst our gallant sailors have borne unscathed the rigour of an Arctic winter. Nevertheless, the grand fundamental law remains untouched. The Great First Cause has distributed His creatures according to the counsel of His will; He has supplied them severally with constitutions, food, raiment, and even medicines suitable to the regions in which they are placed; and the order of His original design is yet maintained by 'fire and hail, snow and vapours; stormy wind fulfilling His word.' Man may make temporary exceptions; but nature knows no inconsistencies. Lions are not found on icebergs, nor do reindeer graze in the region of palms. Esquimaux would perish where negroes revel in the exuberance of nature's gifts. Palms, bananas, and tree-ferns, would be immediately disorganised if placed by the side of the chubby little moss that braves a climate of eternal snows. Nor can the inhabitant of temperate regions, with all his superior advantages, ultimately abrogate the laws of climate. We have no proof of, but, on the other hand, much to disprove, the possibility of even his *permanent* migration from one region to another. History has declared beyond dispute, that the races of different nations cannot by intermarriage propagate a distinct variety through many generations; and, if it be not yet a demonstrable fact, it is, at least, a high probability, that *all* who leave their native soil to reside in foreign climates would ultimately *die out* were this not prevented by the return of their offspring to spend a portion of their lives in the mother country, or through the transfusion of new blood into the veins of their descendants by intermarriage with immigrants fresh from the parent stock. It is not our purpose to argue this point. The question we are to deal with is one touching a *temporary* and not a *permanent* residence in a foreign land. We are to regard climate in its aspect of remedial agent,—as the handmaid of medicine. We are to ascertain to what extent it may be employed to the advantage of one whose precarious health demands a residence in a country where meteorological vicissitudes are either at a minimum, or, at all events, are likely to exercise an influence upon his constitution different from that of his usual habitation.

In the meantime, it is worth considering, briefly, what the circumstances are which, individually and collectively, determine the climate of a country. It will be sufficient to remark concerning our planet, as a whole, that it is spherical in form, having a superficial area of one hundred and forty-eight millions and a half square miles, one-fourth only of which constitutes the dry land, the remaining three-fourths being occupied by water; that it is completely surrounded by a ponderous and mobile fluid known as the atmosphere; and that it is intimately related with, although at a distance of ninety-five millions of miles from, the great luminous centre of the solar system. And we shall find, that the diversity of climate which exists in different regions of the globe depends simply upon the variety of relationship subsisting between these coefficients."

He then considers the following elements of climate,—distance from the equator, elevation, relative position of sea and land, oceanic currents, aspect or exposure of a locality, physical and chemical properties of the soil, state of cultivation, the atmosphere, electricity and ozone, insolation or intensity of solar light, hydro-meteors, rain, dew, prevalent winds, and temperature.

The influence of change of climate on certain kinds of diseases is now generally acknowledged by medical men. Sir James Clark is one of the most prominent writers on this important subject, and his work on climate has led the way in the investigation of the remedial effects of change of air. Dr Jackson tells us that his work is the result of six years' preparation, and that it is grounded partly on personal experience of the sanative influence of the principal winter resorts in the south of Europe and north of Africa. He has spent also three summers amongst the French, Swiss, and German Spas; and he has read every work on climate and cognate subjects which he could procure.

"Medical Climatology is every day taking a stronger hold upon the minds, not only of medical men, but of the general public. Side by side with sanitary science it is developing into a subject of the utmost importance. Preventive Medicine is at length taking up a position commensurate with its value, and it is fostered by the remarkable facilities which now attend the traveller in his wanderings over every part of the world. People look forward to the season when they 'go away' to have their mental and physical condition reinvigorated, after nine or ten months of constant toil. Invalids, too—real invalids—travel much more than in former times, when the wealthy alone could enjoy the privilege. An important question arises out of this widely developed system of migration. 'Where must I go to?' is a form of interrogation which every medical practitioner should be prepared to answer without hesitation. It is a momentous question, however, and demands a careful and accurate reply. In order to become ac-

quainted with the predominating features of particular climates, medical men must either study every work on the subject as it appears, which I venture to believe few have time to do, or they must be supplied with a work containing the requisite information in a condensed and readily consultable form. Such a book, I trust, the reader will find the one now presented to him. It is written in a spirit of impartiality, and with one only end in view, that of furthering the convenience and interests of my professional brethren. I have no particular climate to eulogise above its fellows, no personal interests to serve. I have written it, as I have said, for the accommodation of professional men, and I do not intend it, except, perhaps, in rare instances, to be used as a *guide* by the invalid; he will, if he rightly understands his own welfare, be subject only to his own medical adviser. This principle I have endeavoured to inculcate upon non-professional readers at every opportunity throughout the work; and it has been simply with a view of avoiding circumlocution, that I have seemed in many instances to address my remarks immediately to the invalid himself."

The author, who is an accomplished medical man, enters fully into the subject of Hygienics, and points out the circumstances to be attended to in the preservation of health, as well as in its restoration by change of climate. As to the choice of a residence, he remarks,—“A fair prospect and a pure atmosphere are the points of importance,—‘*Qualis aër, talis spiritus; et cujusmodi spiritus, humores,*’—the former regales the mind, the latter refreshes the body. Plato recommends that no traveller should lodge in a city that is not governed by laws, and that has not a quick stream flowing near it. The invalid will not, however, always meet with those sanitary regulations which are most conducive to health; but he may, at all events, follow the spirit, if not the letter, of the sage’s advice, by adopting a residence in such a locality as is least crowded and somewhat elevated, so as to avoid a vitiated atmosphere and the dampness arising from stagnant waters. There is one circumstance particularly to be remembered,—namely, that in removing to what is understood to be a mild winter climate, at least in southern countries, the traveller will meet with houses that are built not so much with a view of being warm in winter as of being cool in summer; and hence, especially in Italy, they are constructed in such a manner that the sun’s rays can rarely, if ever, gain access to the interior of their apartments, which are usually lighted from an inner court. Such houses are cold and gloomy in winter, and should give place in the invalid’s selection to a warmer and more cheerful edifice. The most desirable aspect for an invalid’s residence is that in which the warmth and light of the sun are enjoyed during the longest period on a winter day, and one which, at the same time,

is protected from the influence of noxious winds. Dampness, the especial bane of all delicate constitutions, should be guarded against by choosing a somewhat elevated situation upon an inclined surface of sandy or gravelly construction; and, with the same object in view, ponds, lakes, and marshes should be avoided. If, however, in spite of these precautions, there be the least suspicion of dampness in the walls of the house, the upper apartments alone should be occupied; and in this manner both financial and sanitary economy may be combined with advantage, for the upper storeys of houses are not only usually the cheaper, but also the more healthy. In addition to other requisites, it is essential that the house have near it a fitting place for out-door exercise. Unfortunately, however, it often happens that the invalid finds himself a martyr at the shrine of fashion; for in almost all places of winter resort the hotels and lodging-houses, which alone have suitable accommodation, are crowded together, and that, too, not unfrequently in an ill-chosen locality. But there is something to be desired beyond the external circumstances of an invalid's dwelling. The view from the windows, as previously mentioned, should be cheerful and engaging; and, still more, the internal arrangements should savour of comfort. The rooms should be lofty and airy; there should be, if possible, a fire-place capable of consuming *coal*; for that is a more wholesome fuel than wood, and at night the apartments should be lighted with candles, for they are less deleterious than gas. Close stoves, hot air, or hot-water pipes, and every variety of *chauffage*, excepting that effected by means of an open grate, is decidedly bad. An uninterrupted ventilation is above all things essential. Without very great attention to this, an invalid, without the least suspicion of it, may occasionally be detected breathing an unwholesome and poisonous atmosphere. And, finally, the in-door temperature should never be made to exceed that of the external air when the latter is at, or above, 60° of Fahrenheit's scale; nor should it be allowed a greater range than 8° or 10° below that point." The subjects of food, baths, sea-bathing, clothing, exercise and sleep, and mineral waters are noticed.

In Chapter IV. a sketch is given of the diseases in which change of climate is to be recommended as a remedial agent, and of the particular localities suited to different ailments. Then follows an account of the various places to which invalids resort, including those in Algeria, Australia, Tasmania and New Zealand, Canada, New Brunswick, Nova Scotia and Newfoundland, Cape of Good Hope, Natal, France, Germany, Belgium, Switzerland, Great Britain, Ireland and the Channel Islands, Italy, Madeira, Azores, Canaries, Spain, Portugal, Gibraltar, Malta, Ionian Islands, Egypt, and West Indian Islands. The work has been drawn up with great care, and contains a large amount of valuable

information. The climates of the different countries are well recorded, and the advantages of different localities clearly stated. The author has added a chart of medical climatology, showing the mean temperature of the principal places on the globe. This chart has been adapted to the work by Mr A. Keith Johnston, the well-known writer on physical geography. We cordially recommend the work, as bringing our information on Climate as a remedial agent up to the present day, and as supplying an excellent manual both for medical men and patients. We would suggest that in a future edition the author should insert a general table of contents, which would add to its value.

Footnotes from the Page of Nature; or, the First Forms of Vegetation. By the Rev. HUGH MACMILLAN. Cambridge, 1861. Macmillan and Co. 12mo, pp. 294.

This is a pleasing and instructive account of what are called the lowest classes of plants—mosses, lichens, fresh-water algæ, and fungi. It is written by one who is enthusiastically fond of botany, and who, while discharging faithfully the higher duties of a clergyman in a Highland parish, does not neglect the prosecution of science. Well would it be for all ministers if they paid attention to natural history in some of its departments. It would supply many illustrations of Scripture, and would lead them to contemplate God in his wondrous works as well as in his Word. To a country clergyman the study of botany is specially attractive. It is a science which he can prosecute at all times, and it furnishes healthful and instructive occupation in his varied perambulations. The attention of the Churches has been called to this subject; and the proposal to require that every Master of Arts in the Scottish Universities shall profess at least one branch of science, such as chemistry, zoology, botany, or geology, will, if carried out, be productive of the best effects.

In the little volume before us Mr Macmillan directs attention to some of the most minute and often despised organisms; and he points out the beauty of the structure of cryptogamic plants, especially when viewed by the microscope, the interesting nature of their functions, and the important uses to which they are subservient. He shows that the study of these plants has a tendency to elevate and enlarge our conception of nature, and that they can be observed and collected without interruption throughout the whole year,—under the cloudy sky of December and in the sunshine of June. They are no summer friends. As Ruskin has beautifully observed, "Unfading as motionless, the worm frets them not, and the autumn wastes not. Strong in lowliness, they neither blanch in heat, nor pine in frost. To them, slow-fingered,

constant-hearted, is intrusted the dark eternal tapestries of the hills; to them, slow-pencilled, iris-dyed, the tender framing of their endless imagery. Sharing the stillness of the unimpassioned rock, they share also its endurance; and while the winds of departing spring scatter the white hawthorn blossoms like drifted snow, and summer duns in the parched meadow the drooping of its cowslip-gold, far above among the mountains, the silver lichen-spots rest, starlike, on the stone, and the gathering orange-stain upon the edge of yonder western peak reflects the sunsets of a thousand years."

The work is illustrated by a coloured plate, and by numerous woodcuts. It is written in an easy popular style. It is not, however, a superficial production. It conveys much correct and valuable botanical information, and is the production of one who knows as well as loves science, and who looks upon nature in its true position as regards revelation. As a specimen of the descriptive power of the author, we quote the following notice of fungi:—

"Having thus given a somewhat lengthened and detailed account of the structure, properties, uses, and other peculiarities of this curious and interesting tribe of plants, it may be proper, in conclusion, to glance at the place which they occupy as æsthetic objects in this fair creation. The careful observer will find the universal spirit of beauty sometimes as aptly and richly represented in these productions of corruption and decay, as in the more admired products of the vegetable kingdom. The very commonest fungi, which grow in the darkest and dreariest spots, are invested with a beauty not absolutely essential to the part which they perform in the operations of nature, or to the efficiency of the organs, whether of absorption or reproduction, with which they are furnished. The fructification of one is a most graceful umbrella, adorned with varied, delicately-shaded hues, and with exquisitely carved veils, fringes, and gills; that of another presents the most beautifully sculptured ivory pores and sinuosities, or richly-coloured tubes or spikes. One species looks like a ruby cup; another is embossed with stars; while the leaves and the grasses of the woods and fields often form niduses for some of the loveliest and strangest forms which our Creator has scattered over the earth with lavish hand, to delight the intelligent and observant eye. There is not in nature a more picturesque object to the painter, or a more interesting study to the botanist, than the old decaying stump of a tree in some lonely unvisited haunt of a shady ancestral wood, where the soil, enriched by the organic contributions of centuries, is bursting into life through every crevice and in every inch. Such a stump, as Wordsworth beautifully says of the mountain, is 'familiar with forgotten years.' It is long since the tall massive oak which it supported has been removed by the axe,

leaving a gap which the encroaching trees around strive in vain to conceal; and nature has kindly smoothed away the traces of man's harsh treatment, and brought it back to perish on its own bosom. Every sunbeam and rain-drop that descended upon it, while crumbling it more, increased its picturesqueness; and while depriving it of its own life, helped to develop upon it other forms of life lower in the scale, until now, it not only adds to the air of antique mystery which pervades the scene, but peoples it with all the fantastic tenantry of Shakspeare's fairy land. In one corner may be observed a cluster of elegant pearl-like mushrooms, wee elfin-looking things with long black stalks, and white wheel-like heads; in another, the corky leaves of a *Thelephora* closely pressed to the wood, with shell-like patterns, and colours as beautifully and dimly shaded on its surface as in a misty rainbow; here the soft, viscid, flesh-like knobs of the *Tremella sarcoides*, resembling tiny teats,—or the wrinkled, quaking, gelatinous mass of the witches' butter, looking more like a frothy exudation from the stump itself than a plant; there a *Spathularia* protruded from a wide, mouth-like gap, like an old woman's tongue, frightening away every young rustic, full of the adventures and transformations of the seven champions of Christendom, from plucking it off, lest the owner, a metamorphosed witch perhaps, should return in proper person to demand her unruly member, and inflict a proportionate punishment; in the middle of the squared top, covered with the minute scurf-like germs of unknown plants, are clustered the beautiful round vermillion balls of the *Lycogala*, or wolf's milk, which, when bruised, exude a dark, grumous liquor like clotted blood; while springing from the crevices of the bark, near the ground, the *Agaricus necator* overtops the rest, with its zoned and olive-coloured cap and dusky stem, distilling, when broken or injured, a blood-like fluid, as though it were a sensitive creature, thus reminding one of Dante's terrific picture of the living forest in the infernal regions. All these, with a score of other curious microscopic plants, hiding themselves from the superficial observer, but revealing themselves openly to a close and minute scrutiny—cup-lichens and trailing green mosses, and slimy green dust-like confervæ, surrounded perhaps with a border of dock-leaves, or a fringe of palmy ferns,—invest the aged stump with a nameless charm in the estimation of all true lovers of the picturesque. And returning from the woods and the fields to the retirement of our own homes, we find that there are forms and living things to be seen there as beautiful, interesting, and suggestive of curious thought, as any we have seen in the wider field of nature out of doors. If we examine under the microscope the green or grey covering which spreads over damp walls, or envelopes a stale piece of bread or fruit in a cupboard, or creams over the surface of preserves, what a wonderful scene of beauty

suddenly unfolds itself like a miracle to our view! Thousands of plummy trees and feathery fern-like plants rear themselves up in every conceivable attitude, and all so delicate and transparent that the minute seeds are seen lodged in the interior of their stems; luxuriant forests draped with pendent parasites, and milk-white mosses enveloping the ground, and clothing old, rotten-looking stumps with beauty, all busy in the fulfilment of their offices, lengthening and swelling, and falling and scattering their minute seeds in little white clouds up and down the surrounding air. He who is privileged to feast his eyes on such a beautiful and instructive spectacle as this, must deeply feel, with the eloquent Ruskin, that 'the Spirit of God works everywhere alike, covering all lonely places with an equal glory, using the same pencil, and outpouring the same splendour in the obscurest nooks, in spots foolishly deemed waste, and amongst the simplest and humblest organisms, as well as in the star-strewn spaces of heaven, and amongst the capable witnesses of His working.'"

Scripture and Science not at Variance; with Remarks on the Historical Character, Plenary Inspiration, and Surpassing Importance of the Earlier Chapters of Genesis.
By JOHN H. PRATT, M.A., Archdeacon of Calcutta. 4th Edition. London: Thomas Hatchard. 1861. 8vo, pp. 158.

It has often been said that the discoveries of science are at variance with the statements of Scripture, and it is sometimes difficult for those who believe in the inspiration of the sacred volume to repel the charge made against it by sceptical men of science. The object of Archdeacon Pratt's work is to present such persons with a reply in a concise and portable form. It points out the difficulties to be met with and the objections to be removed, and tends to strengthen the faith of those who believe the Word of God. The author gives instances in which Scripture and science were supposed to be antagonistic, but which were cleared up by subsequent discoveries. He then enters on an examination of the earlier part of the Book of Genesis, and concludes that no new discoveries, however startling they may appear at first, need disturb our belief in the plenary inspiration of the sacred volume, or damp our ardour in the pursuit of science. The vexed questions in regard to the six days of creation, the origin of man and of species, of death before Adam, the nature of the Deluge, the origin of languages, are ably handled. Many apparent discrepancies are explained, and several false theories are exposed. The author writes as a man of science, and at the same time a believer in the Bible; and he supports his views by able and judicious arguments. "The *hasty* and *immature* deductions of Science may sometimes

stand in opposition to Scripture; but their *settled* results, in which the body of philosophers agree, often confirm and illustrate the statements of the Inspired Volume. Let us then hold firm our grasp upon this truth, that the Scriptures are the infallible Word of God, true in every statement they contain, although the interpretation sometimes demands more knowledge than we at present possess; but let us at the same time remember, that there is no ground whatever for ceasing to pursue science, in all its branches, with an ardent and fearless mind. God's Word and Works never have contradicted each other, and never can do so. The progress of science is inevitable, and it is the glory of man's intellectual endowments. It is the setting forth of the greatness and wisdom of the Creator in His works. Let us therefore push on investigations to the utmost with untiring energy. We have nothing to fear. The greatest perplexities may at any time surround us; but both reason and experience have armed us with arguments which assure us that all will be right. Whatever happens, let our persuasion always be avowed, that Scripture cannot err. Let us be content rather to remain puzzled, than to abandon, or even question, a truth which stands upon so immovable a basis."

God's Two Books; or, Nature and the Bible have one Author. By THOMAS A. G. BALFOUR, M.D. 12mo. London. 1861. James Nisbet and Co. Pp. 132.

The present work is intended to be introductory to one which the author has published on "The Typical Character of Nature; or, All Nature a Divine Symbol." He endeavours to bring forward, in a concise form, some of the arguments in support of the view that Nature and the Bible are two revelations from the same Divine Author,—that the book of nature and the book of grace exhibit a striking similarity in their language, and that both are constructed on the same general plan. He points out that Nature and the Bible are superhuman, that they are inexhaustible, that all in them is regulated by law, that they admit of generalisation in virtue of their constitution, that no systematic arrangement exists in either of them, that both allow vicarious action, that they acknowledge special Divine interposition, that in both there is a law of progression, that simplicity characterises them as well as economy co-existing with abundance, that the same agents in universal destruction are employed in both, that the results obtained are by seemingly disproportionate agency, that in both we find opposite effects resulting from the same agency according as we treat it, that secret and invisible agency is employed in both, and that in Nature and the Bible a unity of pur-

pose is exhibited. In all these respects the two revelations are compared. In speaking of substitution and vicarious action in accordance with law in both Nature and the Bible, the author says: "The doctrine of substitution in chemistry is now a universally admitted fact. Here we find one element replacing another, while still the general character of the compound is maintained, as in the case of iodine, bromine, or cyanogen being substituted for carbon. Again, in the case of ammonia (NH_3), we have one or more equivalents of the hydrogen replaced by one or more equivalents of methyle, æthyle, propyle, butyle, &c., and yet the type and chemical relations of NH_3 are retained. Laurent, indeed, has adopted a nomenclature, by means of which, if we know the composition of the original substance, we can at once tell that of the new one obtained by substitution. It consists in employing the different vowels for the different proportions of the vicarious element. Again, in the case of ether ($\text{C}_4\text{H}_5\text{O}$) we have the substitution of chlorine for the one atom of oxygen and for each of the five atoms of hydrogen, in which case the replacement is complete, and we have all the intermediate gradations till we reach C_4Cl_5 . The alums also afford a good example of the same doctrine. . . . We find also in the constitution of some plants that, when they grow near the sea, soda may replace potash. The whole class of types which occurs in the structure of vegetables and animals affords plain evidence that the same law holds good here also. But in chemistry we have a much more close resemblance to the moral substitution; for we find that it is only among congeners that this permission is granted. . . . Vicarious action, then, is an acknowledged fact in nature. It produces, as it were, 'the balance of power' among the different organs, and secures the safety and well-being of the individual; and as God acts on this principle in the physical creation, so in the moral it is found holding a prominent place, for it is the grand central point of all Revelation. Every promise had reference to this; every bleeding sacrifice proclaimed significantly the same great truth; the scape-goat, led to the barren wilderness with confessed sins of the people on its head, teaches the same all-important lesson; the priesthood itself is in the room of the first-born, while it also points to the High-Priest of our profession."

The work indicates the importance of placing science and history side by side with the Bible, and of studying their mutual bearings and harmonies. In these days, when a tendency has been shown by men such as the writers of the "Essays and Reviews" to subvert entirely the Divine authority of the Sacred Volume, it is well to have such a work as the present, which brings out the common Divine origin of the twofold revelation in Nature and in the Scriptures.

A Manual of the Sub-Kingdom Cœlenterata. By JOSEPH REAY GREENE, B.A., Professor of Natural History in the Queen's College, Cork. London, 1861. Longman & Co. 12mo, pp. 271.

The author of this work is already favourably known by his "Manual of Protozoa," with a general introduction on the Principles of Zoology—which is an excellent text-book for students. The present volume is an abridgment of a larger work, which the author hopes ere long to publish. The Cœlenterata include such animals as the Hydra, Sertularia, Medusa, Actinia, and Zoo-phyte. They are all furnished with an alimentary canal, freely communicating with the general or somatic cavity. The substance of the body consists essentially of two separate layers; an outer, or ectoderm, and an inner, or endoderm. These two membranes, but especially the former, are in general provided with cilia. In the integument of these organisms we constantly meet with peculiar thread-cells, which, when they come into contact with the human skin, frequently produce disagreeable stinging sensations. The sub-kingdom is divided into two orders:—1. *Hydrozoa*, in which the wall of the digestive sac is not separated from that of the somatic cavity, and the reproductive organs are external; 2. *Actinozoa*, in which the wall of the digestive sac is separated from that of the somatic cavity by an intervening space, subdivided into chambers by a series of vertical partitions, in the faces of which the reproductive organs are developed. The author gives the morphology, physiology, classification, and distribution as regards space and time, of the animals included in these two orders. The facts are stated in a clear and interesting manner, and are illustrated by numerous excellent woodcuts. The author has given the most recent observations in regard to the anatomy and physiology of the animals, and has produced a manual of great value to the student of zoology, to whom these lower types of animals must ever present attractive subjects for observation. Physiology is indebted in no small degree for its progress to the labours of naturalists who have made researches into the functions of these animals, and we do not know any department of natural history more deserving of attention. Much has been done of late years in the illustration of the various divisions of the Cœlenterata by Forbes, Allman, Huxley, Hincks, Busk, Strethill Wright, Gosse, Agassiz, Sars, Siebold, Steenstrup, Müller, Milne-Edwards, Gegenbaur, Leuckart, and others. We have much pleasure in recommending Mr Greene's work as an excellent epitome of all that has been done by these authors. There is a valuable bibliography appended, along with a series of questions which are well calculated to test the student in regard to his knowledge of the subject.

PROCEEDINGS OF SOCIETIES.

*Royal Society of Edinburgh.**Monday, 2d December 1861.*

The Very Reverend DEAN RAMSAY, V.P., delivered an Opening Address, which will be found at page 79 of this Journal.

Monday, 16th December 1861.

The following resolution was unanimously adopted :—

That out of respect to the memory of H.R.H. the Prince-Consort, and in consideration of the heavy affliction which has befallen Her Majesty and the nation at large, this Society do now adjourn till Monday 6th January 1862.

Botanical Society of Edinburgh.

Thursday, 14th November 1861.—Dr W. H. LOWE, the President, delivered an Opening Address.

The following communications were read :—

1. *Extracts from Letters written during a Voyage to Alexandria.* By Dr HUGH CLEGHORN. Communicated by Professor BALFOUR.

“Off Algiers, steamer Indus, Sept. 23, 1861.

“Between Ushant and Cape Finisterre our vessel passed through troubled waters—the equinoctial disturbances were punctual, and we are a full day behind time. During the last three days I have scanned with a telescope parts of the shores of Portugal, Spain, and Africa, which are new to me, and I shall introduce a few notes from my diary as to sights in Gibraltar and Malta which may seem likely to interest you. The coast of Portugal had a very parched appearance, and did not look inviting to botanists. On the Rock of Lisbon we saw the large windmills and white convents mentioned by Dr Hooker in his botanical notes (*Kew Miscellany*, May 1848). There were a few traces of vegetation on the cliffs, which I imagined to consist of olive bushes and cork oaks. A naval paymaster, who has visited Cintra, told me that these trees grow larger in the valleys over the first range of hills. On the 26th we sailed into the Straits of Gibraltar, and enjoyed a splendid view of the Atlas Mountains in Africa, and of Sierra Nevada in Spain. There are some patches of recent snow upon the latter, showing that winter is not far off. We landed for 1s. each at the Old Mole. Above and between the apertures of the parallel galleries of this remarkable fortress caper bushes were seen hanging. The stupendous rock was otherwise scorched and bare. Armstrong guns are being added to strengthen the defences. The fruit-market lies close to the quay, and outside the drawbridge; it is fairly supplied with the following varieties :—Quinces, peaches, apples, pomegranates, grapes, olives, Spanish chestnuts, walnuts, filberts, stone pine seeds, Castile melons, &c. About 4 lb. of grapes and several pomegranates, in a plaited grass basket of Esparto (*Lygeum Spartum*, L.), are sold for 1s.; if homeward bound, I would have brought a basket for the Museum. We walked along the main street towards the Almeida or public pleasure-grounds. Passing the Post-Office and Library (a very good collection),

and entering into an old Roman Catholic church, full of antique carving, pictures, and relics, we passed sentries, magazines, and barracks. On the parade-ground were soldiers of three of H.M.'s infantry regiments and many artillery. The glare of the sun was broken by the shade of a double row of *Phytolacca dioica*, which is planted in avenues along the public promenades. The foliage is dense and umbrageous, resembling *Ficus Tsiela*, the trunk short and stout like that of *Adansonia*. In the public gardens we observed *Aloe*, *Agave*, *Opuntia*, *Chamærops*, *Ricinus*, *Melanthus* (from South Africa). There are several fragrant Labiate plants and shrubby *Acanthaceæ*, *Geranium* (several), *Genista* (several) — *Sedum* covering the rocks. Of trees, the most striking are *Olea*, *Tamarix*, *Pinus*, *Thuja*, and *Acacia lophantha* (from South Australia). It is always interesting to watch the introduction of plants at such places as Aden and Gibraltar. In the crevices of the rocks, the large bulbs of *Scilla maritima* were impacted, throwing up beautiful scapes of flowers. Almost all the other plants were in fruit—this being the close of the hot weather. I secured some Spanish broom seeds for the Nilgiris, and Castile melons for the Madras Gardens. By moonlight the view was very fine—the town brilliantly lighted up with gas, the great rock towering up 1000 feet behind, and on the opposite side the African mountains being seen in outline. Dr Sutherland, Inspector of Hospitals, who was sent to the Crimea on special duty, joined us here, with Captain Douglas Galton, Royal Engineers; they are now reporting on the barracks and fortifications of the Mediterranean stations.

"After leaving Gibraltar we coasted along the province of Malaga, and afterwards sighted Algiers, which appears to be strongly fortified—there are lines of white houses belonging to French residents. I much wished to have landed and seen the gardens alluded to in Giles Munby's "*Flore d'Algérie*." There is occasional steam communication between Malta and Algiers.

"30th.—Tunis visible at 8 A.M. after passing the uninhabited islands of Zembra and Zembratta, and another rocky one (Pentalaria), which is said to have been the penal settlement to which King Bomba exiled troublesome subjects. We could see the prison and the terraced vineyards. The population is very depraved. I had nearly forgotten to mention that of three Wardian cases entrusted to me from Kew, one for Thwaites was much broken in the Bay of Biscay, but subsequently repaired. I keep a glass case containing Cinchona plants in my cabin, and trust that they may reach in safety. You know, perhaps, that Dr T. Anderson has been ordered on a special mission to Java connected with Cinchona culture, which will afford him great opportunities of exploring the Dutch possessions in India."

"*Shepherd's Hotel, Cairo, 7th October 1861.*

"Immediately after arrival at Alexandria at daylight on the 5th, we received the astounding intelligence that the Nile had risen to an unusual height two days previously, overflowing the embankments, causing great destruction of life and property, and carrying away many miles of the railway between Alexandria and Cairo. It was ten hours before we received intimation as to future progress, during which we went to look at the riches of an Eastern Bazaar, and afterwards to see the lions of that remarkable city—Pompey's Pillar, Cleopatra's Needle, and the Mahmoudi Canal, upon which the Pasha's gardens and the merchants' houses are situated. There was nothing very interesting in the latter, which is thoroughly Oriental. There were great masses of showy flowers—*Hibiscus*, *Oleander*, and *Lantana*; the inner edging generally consisted of rosemary. On the banks of the canal, which in the evening were crowded with carriages, and seemed to be the fashionable mall or course of the inhabitants, the

characteristic plants were date palms in full fruit, tamarisk and cypress trees, and in the water *Papyrus* and *Saccharum*. After a late *table d'hôte*, we were despatched in the old desert vans to the railway station, where we travelled twenty miles, and were then put on board a small Nile steamer. We received special injunctions to carry nothing heavier than a carpet bag, but I was determined to carry the Cinchona glass case which was given to me at Kew, and have been able to bring it hitherto, but it has been for the last two days a source of continual anxiety by night and by day, and has been carried on through various trans-shipments with much difficulty. As Indian travellers do not now-a-days voyage on the Nile, this has been a remarkable incident in our wanderings. The whole country was flooded often as far as we could see—the usual landmarks for steering were submerged, and here and there we noticed the tops of trees in passing: while near *Kafir Zayat* we saw part of a railway engine and several carriages standing out of the water. On little islands and small raised embankments were long lines of villagers, with their camels, buffaloes, and sheep, and piles of furniture and goods to the water edge. I have been inquiring of the officials here as to the real state of matters, and am informed that the Nile rose $4\frac{1}{2}$ feet above the usual average. The origin of the catastrophe is said to be the abolition of the establishment for watching the embankments, and whose duty it was to attend to the sluices, and repair any breach without delay. This evening the river is said to have subsided forty inches, so that it is not now more than a foot above the usual height at this season. The great question now is, to obtain an immediate and abundant supply of seed for the next crop; urgent applications have been made to the Pasha, but no reply has as yet been received. The *barrage* of the Nile, which cost two millions of money, and spoiled the navigation of the river, was our greatest obstacle; the current rushing through was prodigious, and the difficulty of encountering it was not small; the steering not being steady, the paddle-wheels touched the banks, and were slightly damaged. Our merciful preservation amid these strange and perilous scenes calls for the strongest expression of our gratitude. I had opportunity of examining in every tumbler of water the rich deposit of the Nile, which is even more abundant than that of the Ganges in the Delta. From conversation in the market-place, I fear that much Egyptian cotton has been destroyed as it was ripening. The public funds have been affected, and the cost of restoring the railway will be very great. The Pasha himself was visible, walking along the famous bridge built by G. Stephenson, surveying the effect of the inundations; we saw him leaving his state barge, which was towed by a small river-steamer, built in Glasgow. I have seen great floods in India, but generally the plains were soaked with rain, which caused the flood; here a vast extent of dry, parched land was inundated with fluid mud—the very edge of the river being hot sand or baked soil of brick-like hardness. The rain evidently falls on the mountains far distant in the interior of Africa.”

2. *Measurements of Trees at Dryburgh Abbey; and Caver's Carre, Roxburghshire.*—By Dr JOHN ALEX. SMITH.

(1.) *Dryburgh, September 1861.*

	Circum.
1. An old yew tree taken at 4 feet from the ground.	10 ft. 6 in.
2. A cedar of Lebanon near the Abbey, taken at same height	6 4
3. A horse-chestnut near the house	10 4
4. A beech near the offices, at the damside	13 6

5. An old cedar of Lebanon, near the house and close by the dam	11	4
6. A silver fir east of the house	12	5
7. A larch do. do.	8	4
8. A cedar of Lebanon	7	8
9. A cedar of Lebanon	7	4
10. A cedar of Lebanon	8	0
11. Elm	7	10
12. Elm	10	2
13. A tall spruce	7	0

(2.) Caver's Carre, March 1860.

1. Silver fir taken $4\frac{1}{2}$ ft. from the ground	13	6
2. Do. do. do.	12	3
3. Do. do. do.	12	2
4. A beech do. do.	11	4
5. Do. do. do.	12	0
6. Do. do. do.	10	0

The cedars of Lebanon, with one exception—viz., the largest—seem to have been planted in 1814. They appear to have suffered a little from the severe frost of last winter, the upper branches of some of the trees having rather a scathed-like appearance, with the foliage not so thick and rich as usual. Speaking from memory, I should think these cedars would range about thirty feet in height, or a little more.

12th December 1861.—WILLIAM BRAND, Esq. in the Chair.

The following communications were read :—

I. *Notes of a Trip to the North of Italy and Chamouni, in August and September 1861.* By Professor BALFOUR.

In this paper the author described his visit, along with the Rev. Dr A. Thomson, to Paris, Lyons, Marseilles, Genoa, Leghorn, Pisa, Florence, Bologna, Milan, Turin, Latour and the Waldensian Valleys, Arona, Lago Maggiore, Domo d'Ossola, Simplon, Brieg, Sion, Lausanne, Geneva, and Chamouni, and noticed briefly some of the more interesting plants which had been observed. Among those seen in the neighbourhood of Genoa were enumerated the following :—*Olea europæa*, *Platanus orientalis*, *Tamarix gallica*, *Capparis spinosa*, *Carthamus lanatus*, *Medicago sativa* and *falcata*, *Quercus Ilex* and *coccifera*, *Nerium Oleander*, *Mirabilis Jalapa*, *Euphorbia palustris*, and *Cyparissias*, *Lactuca Scariola*, *Punica Granatum*, *Colutea arborescens*, *Cercis Siliquastrum*, *Convolvulus iculus*, *Ficus Carica*, *Morus nigra*, *Myrtus communis*, *Ornus europæa*, *Schinus Molle*, *Pistacia Lentiscus*, *Centaurea Calcitrapa*, *maculosa* and *alba*, *Arbutus Unedo*, *Clematis erecta*, *Dianthus Carthusianorum* and *sylvestris*, *Gypsophila repens*, *Cytisus triflorus*, *Spartium junceum*, *Psoralea bituminosa*, *Lotus diffusus*, *Genista germanica* and *cenisia*, *Dorycnium hirsutum*, *Senecio albicans*, *Eryngium campestre*, *Crithmum maritimum*, *Rubia peregrina*, *Scabiosa canescens* and *lucida*, *Aster acris*, *Pulicaria dysenterica*, *Borckhausia setosa* and *fetida*, *Carduus defloratus*, *Veronica spicata*, *Verbascum Thapsiforme* and *Lychnitis*, *Scrophularia canina*, *Euphrasia lutea*, *Sideritis hyssopifolia*, *Salvia pratensis*, *Mentha sylvestris* and *rotundifolia*, *Phytolacca dioica*, *Smilax aspera*, *Allium angulosum*, *Cynodon Dactylon*, *Setaria viridis*, *Panicum Crus-galli*, *Arundo Donax*, *Adiantum Capillus-Veneris*. A tolerably full list was given of the plants found on the Vaudois Alps, chiefly from specimens supplied by M. Rostan. The following may be recorded :—

Ranunculaceæ.

- Actæa spicata*, *L.*
Anemone baldensis, *L.*
Aquilegia alpina, *L.*
Atragene alpina, *L.*
Ranunculus glacialis, *L.*
plantagineus, *All.*
Villarsii, *DC.*

Cruciferae.

- Arabis alpestris*, *Sch.*
brassicæformis, *Wall.*
cœrulea, *Wulff.*
muralis, *Bert.*
pedemontana, *Bert.*
Cardamine impatiens, *L.*
pratensis, *All.*
sylvatica, *Link.*
Cheiranthus pumilus, *L.*
Dentaria pentaphyllos, *L.*
Draba aizoides, *L.*
muralis, *L.*
Hugueninia tanacetifolia, *Rehb.*
Hutchinsia alpina, *Br.*
Iberis pinnata, *L.*
Nasturtium pyrenaicum, *Br.*
Petrocallis pyrenaica, *Br.*
Thlaspi alpestre, *L.*
arvense, *L.*
virgatum, *G.*
Vesicaria utriculata, *Lam.*

Papaveraceæ.

- Papaver argemonoides*, *Cesati.*

Fumariaceæ.

- Corydalis fabacca*, *Pers.*
solida, *Hook.*

Cistaceæ.

- Helianthemum alpestre*, *Dun.*

Violaceæ.

- Viola ambigua*, *W. & K.*
canina, *L.*
cenista, *All.*
collina, *Bes.*
nummularifolia, *All.*
odorata, *L.*
pinnata, *L.*
sciaphylla, *Koch.*
scotophylla, *Good.*
sepincola, *Good.*
sylvatica, *Lam.*
valderia, *All.*

Droseraceæ.

- Aldrovanda vesiculosa*, *L.*

Polygalaceæ.

- Polygala calcarea*, *Sch.*

Caryophyllaceæ.

- Arenaria verna*, *L.*
Villarsii, *Ball.*
Cerastium lineare, *All.*
Dianthus atrorubens, *All.*
deltoides, *L.*
Mœnchia mantica, *Bart.*
Silene nutans, *L.*
Tunica saxifraga, *Scop.*

Linaceæ.

- Linum gallicum*, *L.*

Leguminosæ.

- Astragalus aristatus*, *Hert.*
Onobrychis, *L.*
Cytisus alpinus, *Mill.*
nigrescens, *L.*
Lathyrus heterophyllus, *L.*
sylvestris, *L.*
Onobrychis montana, *DC.*
Oxytropis campestris, *DC.*
montana, *DC.*
Phaca alpina, *L.*
australis, *L.*
Trifolium badium, *Sch.*
Molineri, *Balb.*
pannonicum, *L.*
scabrum, *L.*
strictum, *L.*
Vicia pisiformis, *L.*
sylvatica, *L.*

Rosaceæ.

- Dryas octopetala*, *L.*
Potentilla Fragariastrum, *Ehr.*
minima, *Hall.*
valderia, *Sm.*

Lythraceæ.

- Suffrenia filiformis*, *Bellar.*

Onagraceæ.

- Circœa alpina*, *L.*
Epilobium angustifolium, *L.*
Fleischeri, *Hochst.*
rosmarinifolium, *Henk.*

Illecebraceæ.

- Paronychia polygonifolia*, *DC.*
Herniaria incana, *Lam.*

*Crassulaceæ.**Sedum alsinifolium*, *All.**Saxifragaceæ.**Saxifraga exarata*, *Vill.*

Cotyledon, *L.*
diapensioides, *Bell.*
pedemontana, *All.*
purpurea, *All.*
valdensis, *DC.*

Umbelliferae.

Bupleurum ranunculoides, *L.*
Myrrhis odorata, *Scop.*
Plycotis heterophylla, *Koch.*

*Galiaceæ.**Galium pedemontanum*, *All.**Valerianaceæ.**Valeriana tuberosa*, *L.**Compositæ.*

Achillea nana, *L.*
Adenostylis leucophylla, *Rehb.*
Artemisia glacialis, *L.*
spicata, *Jacq.*
Chrysanthemum montanum, *L.*
Doronicum austriacum, *Willd.*
Clnsii, *Tausch.*
scorpioides, *Willd.*
Filago arvensis, *L.*
Hypochaeris uniflora, *Vill.*
Senecio incanus, *L.*

Campanulaceæ.

Campanula alpestris, *All.*
Elatines, *L.*
stenocodon, *Boiss et Reut.*

Ericaceæ.

Pyrola minor, *L.*
Monotropa Hypopitys, *L.*

Gentianaceæ.

Gentiana brachyphylla, *Vill.*
ciliata, *L.*
excisa, *Koch.*
Rostani, *Reuter.*

Boraginaceæ.

Cerinth minor, *L.*
Pulmonaria saccharata, *Mill.*

*Scrophulariaceæ.**Bartsia alpina*, *L.**Euphrasia lanceolata*, *Lam.*

Odontites, *L.*
salisburgensis, *Funk.*

Pedicularis fasciculata, *Bellar.*

foliosa, *L.*
incarnata, *Jacq.*
rosea, *Jacq.*
rostrata, *L.*
verticillata, *L.*

Scrophularia vernalis, *L.**Veronica Allionii*, *Vill.**bellidifolia*, *L.**urticaefolia*, *L.**Labiatae.**Calamintha grandiflora*, *Moench.**piperella*, *Reitt.**Galeopsis angustifolia*, *Ehrh.**intermedia*, *Vill.**Teucrium lucidum*, *L.*

Pinguicula alpina, *L.*
vulgaris, *L.*

*Primulaceæ.**Androsace carnea*, *L.**obtusifolia*, *All.**Aretia vitalliana*, *Lap.*

Primula latifolia, *L.*
villosa, *Jacq.*

*Polygonaceæ.**Polygonum alpinum*, *All.**Scleranthaceæ.**Scleranthus biennis*, *Reuter.**Salicaceæ.**Salix hastata*, *L.**Orchidaceæ.**Orchis incarnata*, *L.**Serapias longipetala*, *Pollin.**Liliaceæ.**Allium sphaerocephalum*, *L.**Tulipa præcox*, *Tenor.**Juncaceæ.**Juncus alpinus*, *L.**capitatus*, *Weigel.**Jacquini*, *L.**Luzula nivea*, *Desv.**pedemontana*, *Boiss et Reut.**spadicea*, *DC.*

*Cyperaceæ.**Carex curvula*, *All.**Gramineæ.**Agrostis pumila*, *L.**Aira flexuosa*, *L.**Alopecurus Gerardi*, *Vill.**Avena versicolor*, *Vill.**Bromus squarrosus*, *L.**Festuca flavescens*, *Bill.**Oreochloa pedemontana*, *Boiss et Reut.**Poa cenisia*, *All.**Stipa Calamagrostis*, *Whlberg.**Vulpia ligustica*, *Rehbch.**Equisetaceæ.**Equisetum variegatum*, *Sch.**Filices.**Asplenium fontanum*, *DC.**Blechnum Spicant*, *L.**Lastrea dilatata*, *L.**rigida*, *Presl.**Polypodium Robertianum*, *Hoff.**Woodsia hyperborea*, *R. Br.*

The author gave details of his visit to Chamouni, the Brevent, Flegère Montanvert, the Jardin, Tête noir, and Martigny, in company with Mr C. Cowan and Mr Thomas Chalmers. The following were some of the plants collected in the Jardin district:—

Cardamine resedifolia, *L.**Arenaria biflora*, *L.**Silene acaulis*, *L.**rupestris*, *L.**Trifolium alpinum*, *L.**Alchemilla alpina*, *L.**Potentilla grandiflora*, *L.**Epilobium alpinum*, *L.**Sempervivum arachnoideum*, *L.**Saxifraga aizoides*, *L.**aspera*, *L.**bryoides*, *L.**stellaris*, *L.**Astrantia minor*, *L.**Athamanta cretensis*, *L.**Bupleurum stellatum*, *L.**Meum mutellinum*, *Gærtn.**Apargia alpina*, *Hust.**autumnalis*, *Willd.**Adenostylis alpina*, *B. et F.**Carduus spinosissimus*, *L.**Carlina acaulis*, *L.**Chrysanthemum alpinum*, *L.**Hieracium alpinum*, *L.**angustifolium*, *Hopp.**aureum*, *Scop.**cymosum*, *Vill.**Gnaphalium alpinum*, *L.**Senecio incanus*, *L.**Tussilago alpina*, *L.**Campanula Trachelium*, *L.**Phyteuma humile*, *Sch.**spicatum*, *L.**Vaccinium uliginosum*, *L.**Vitis-Idæa*, *L.**Gentiana purpurea*, *L.**Euphrasia salisburgensis*, *Funk.**Linaria alpina*, *Desf.**Veronica saxatilis*, *L.**Acinos vulgaris*, *Pers.**Primula glutinosa*, *L.**Juniperus communis*, *L.**Luzula spadicea*, *DC.**Carex foetida*, *All.**Agrostis alba*, *L.**alpina*, *Scop.**vulgaris*, *With.**Alopecurus pratensis*, *L.**Phleum alpinum*, *L.**Poa alpina*, *L.**laxa*, *Hænke.**Allosorus crispus*, *Bernh.**Bryum androgynum*, *Hed.**Cetraria islandica*, *Ach.*

He also described what he had seen of the remains of the guides who had perished by the avalanche during Dr Hamel's ascent of Mount Blanc in 1820. These remains made their appearance in July 1861, in the Glacier Bossons. They consisted of bones, teeth, hair, the remains of hat, gaiters, buttons, mittens, lantern, and baton. Their appearance at this period confirmed the statements of Principal Forbes as to the movements of glaciers.

During the whole excursion the heat was excessive,—Fahrenheit's thermometer rising to upwards of 90° in the shade. The vegetation had suffered much from the heat and drought. The Arno, at Florence,

could be crossed at some parts dry-shod, and the melting of the glaciers gave rise to inundations in the valley of the Rhone.

The paper was illustrated by specimens of the plants collected.

2. *Notes on the Cyperaceæ*—(1.) *Carex Grahmi* (Boott); (2.) *Scirpus* (*Eleocharis*) *uniglumis* (H. C. Wat). By BENJAMIN CARRINGTON, M.D., Lincoln. Communicated by Professor BALFOUR.

(1.) *Carex Grahmi*, Boott.

While engaged making drawings of the *Carices*, some time ago, I found, mingled with specimens of *C. saxatilis*, L., from Glen Fee, Clova, two or three plants of larger size, and differing in several respects from the rest. The spikelets were larger, straw-coloured. Glumes acute, much shorter than the pale *elliptic-oblong*, inflated perigynium, distinctly 4-5 *ribbed*. The nut was abortive in all the spikes, although mature nuts were present in *C. saxatilis*. The perigynium of the latter is of smaller size, *oval*, *ribless*, and like the glumes, which it equals in length, of a *deep purple* colour. These characters led me to identify the plant with *C. Grahmi*, which Dr Boott appears to have considered a good species.

Wishing to obtain more information, I wrote to Professor Balfour (May 1858), and he was good enough to forward me the specimens preserved in the College Herbarium.

In his reply, he remarks, that "*C. Grahmi* is confined to one spot in Glen Fee, pretty high up on the rocks; whilst *C. saxatilis* occurs commonly in marshy ground, on most of our high hills."

The significance of this information will be better understood, when I state, that in one of the Herbarium specimens, we find, springing from the same rhizome, spikes apparently of both kinds. The one, having the dark, ribless perigynium of *C. saxatilis*; the other, the large, stunted, and abortive fruit of *C. Grahmi*. We frequently meet with deformed perigynia in *Carex intermedia* (*disticha*), accompanied by abortion of the nut.

This change is probably due to some morbid action of a local nature, by which the growth of the germen is arrested, and the perianth is developed at its expense.

C. Grahmi retains all its peculiarities under cultivation, and looks even more unlike *C. saxatilis*. When in Ireland (June 1861), Mr D. Moore, of Glasnevin, was kind enough to show me fruiting plants of both kinds. Upon dissection, however, I found the fruit of *C. Grahmi* enclosing only the undeveloped germen, as in the wild specimens.

(2.) *Eleocharis palustris*, and its Allies.

In the fourth edition of "Babington's Manual," we find descriptions of three species of *Eleocharis*, with lenticular fruit, dilated articulate styles, and two stigmas.

Having carefully dissected the species, the following notes may be found useful to others. It should be understood that all descriptions of the fruit refer to the ripe Caryopsis. Plants with mature fruit, especially of the rarer species, are obtained with great difficulty. This may account for inaccuracies of detail, even by such careful observers as Professor Babington. Thus he calls the fruit of *E. palustris*, round-obovate; of *E. uniglumis*, pyriform; and *E. Watsoni*, oblong; whereas I have invariably found that of the first *exactly obovate*, and of the two latter *bluntly rotund-obovate*.

Eleocharis palustris, L.—*Rhizome* extensively creeping, woody, giving

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off fascicles of stems from the upper surface of the nodes, and fibrous roots below. *Stems* 6 to 12 inches high, terete, finely striate, the interior filled with large membranous tubes, but without central pith. *Sheaths* purplish-brown, glossy, the upper one tight, *truncate*, with an *obtuse angle* on one side. Leaves none, although the barren stems may be mistaken for leaves. *Spikes* ovate or ovate-oblong, solitary, terminal. *Glumes* purple, ovate, acute, with a green midrib, and broad membranous edges; the *two lower glumes equal*, shorter, and more obtuse than the rest. *Bristles* 4, setaceous, as long as the fruit, with recurved teeth, dilated and smooth at the base. *Stigmas* 2, downy, equal to the dilated, battle-dore-shaped, persistent, jointed style. *Caryopsis* pale-brown, lenticular, obovate, with blunt margins; the surface polished, finely striate, and covered with narrow, oblong reticulæ.

Eleocharis uniglumis, Link.—In its creeping rhizome, glossy obtusely truncate sheaths, and general habit, this plant resembles the former so closely, that many botanists look upon it as a mere uniglume variety of *E. palustris*. It is far from a good species. But in the present state of uncertainty as to the limits of species, it is perhaps better to give a name to a permanent variety, than leave it undescribed. It differs chiefly in the *lower glume* being single, and enclosing the base of the ovate spike. The base of the *style* is less constricted, *broader*, and *triangular* or *pyramidal* in form. *Fruit* smaller, *rotund-obovate*, more tumid and bi-convex, glossy, the surface beautifully *excavato-punctate*, like the marking on a thimble. The cells are larger, and round in this species, and *E. Watsoni*; whereas, in *E. palustris* they are narrower, giving the nut a more striate appearance.

β. *Watsoni*. *Eleocharis Watsoni*, Bab., *Annals Nat. Hist.*, Ser. 2, x. 32. Through the kindness of Professor Balfour, I have been allowed to examine the remnant of the original specimen, shared with Professor Babington. It consists of three stems, from 2 to 3 inches high, broken off close to the rhizome. These might readily be overlooked as a stunted variety of *E. pauciflorus*, but the sheaths are purple and *polished*, and *obtusely truncate*, as in the former species. The *lower glume* is solitary, obtuse, surrounding the base of the spike, the upper glumes more acute. *Nut* orange-brown polished, *bluntly rotund-obovate*, compressed, with rounded margins, *excavato-punctate*, and crowned with the broad triangular style, exactly as in *E. uniglumis*. The only point of difference seems to be the comparative length of the *bristles*. They are four in number, and dilated at the base, as in the former, but only *about half as long* as the ripe fruit. I observed, however, that they were relatively longer in some of the upper and less mature florets; and as the bristles are known to be more sportive than any other organs throughout the Scirpææ, this character can only entitle it to be ranked as a variety (perhaps an alpine state) of *E. uniglumis*. Babington describes the fruit as oblong, but this can only apply to the immature germen; it is when ripe nearly round, slightly narrowed at the base.*

The species may be thus defined:—

Stigmas 2, *style jointed*, *bristles* 4, *retroarsely hispid*.

1. *E. palustris*, L. Rhizome creeping, sheaths polished, obtusely truncate, two lower glumes equal, nut smooth, finely striate, obovate, compressed, crowned by the ovate base of the style, bristles 4, longer than the germen.

2. *E. uniglumis*, Link. Rhizome creeping, sheaths obtuse, lower

* *E. pauciflorus* may be distinguished from it by its 3 stigmas, trigonous nut, and the style not being jointed.

glume solitary, nut lenticular, rotund-obovate, polished, excavato-punctate, surmounted by the triangular base of the style, and shorter than the 4 bristles.

β. Watsoni. Glumes rather obtuse, bristles 4, about half the length of the nut.

Mr. M'Nab laid before the meeting several sections of Scotch fir beams, taken from the ruins left by the late catastrophe in the High Street of Edinburgh. These beams had been originally prepared by a rough squaring with an axe, as the corners of each present a smooth appearance, showing where the bark had been removed; and several portions had the bark quite entire, unmistakably proving them to be Scotch fir. In most cases the timber is in excellent preservation, particularly the centre or hard wood. The beams are generally of small sizes, varying from five to eight and ten inches in diameter. The annual circles are very distinct, averaging about fifty-seven in each, showing that the timber, when cut down, was under sixty years of age. He had examined most of the beams while lying for sale in the Green Market, and found that, where the annual rings could be counted, the trees appeared to be all about the same age. Judging from the long and thin nature of the stems, they must have grown very close together; but whether they are Boroughmuirhead or Aberdeenshire timber, it is difficult to say. If the beams were made of Boroughmuirhead fir, one would suppose that they should have been of much larger size and considerably older. It is doubtful if timber sawn up for rough building purposes, as now used, will last as long as timber with all its heart-wood entire—such as has been employed in these old buildings. A few large sawn fir beams 1 foot broad and 7 inches thick, with large annual rings, were likewise seen amongst the ruins; but their ages could not be ascertained, as they are only the centres of trees. Their freshness, their rarity, and being sawn into their present shape, would make one suppose them to have been of more recent date than the mass of axe-dressed timber. A few beams of oak were also got amongst the ruins—rough axe-squared, similar to the Scotch firs—the outer or sap wood very much decayed, while the inner or heart-wood was quite perfect, and very dense. Their supposed age when cut must have been about eighty years.

Mr J. Sadler stated to the meeting that in the "Phytologist" for this month (December 1861), at page 378, it is stated, on the authority of an anonymous collector, that *Saxifraga cernua* occurs abundantly on Ben Ledi. This he looked upon as a mistake. The collector had probably mistaken *Saxifraga nivalis* for *S. cernua*. Mr Sadler and many others, including Professor Balfour and his class, had visited Ben Ledi, and examined it carefully, but had never seen *Saxifraga cernua*, which in Britain seems to be wholly confined to Ben Lawers.

Mr William R. M'Nab exhibited specimens of *Coleoptera* he received from George Patton, Esq., which had been destroying the *Conifera* in the Pinetum at the Cairnies, Perthshire. *Hylobius abietis*, Linn., the pine-weevil, and *Gonioctena litura*, Fab., seemed to be the insects that did the mischief; but the most remarkable fact was the occurrence of *Mysis oblongoguttata*, Linn., which, in company with a very large number of *Anatis ocellata*, Linn., had committed such havoc in search of the Aphides on which they feed, that the value of Lady-bugs in destroying these Aphides was doubted; and when they occurred in such numbers as they were found by Mr Patton, they had become positively injurious.

Mr W. R. M'Nab also exhibited a piece of the bark of *Wellingtonia gigantea* acted upon by a salt of iron, which indicated the presence of tannin.

Mr R. Brown laid before the Society several specimens of the following rare or remarkable *Algæ* from Brighton:—

(1.) *Dasya*, sp.? allied in the form of its vesicles to *Dasya ocellata*, and in its habits to *Dasya arbuscula*; closely connected, if not specifically the same, with *Dasya punicea* of the Mediterranean.

(2.) *Phyllophora*, sp.? allied to *P. rubens*, but apparently distinct, if specimens connecting the two forms are not found.

1st, With tubercular fruit wrinkled with sinuous processes.

2d, With leaflets covering nemathecia.

3d, The same less advanced, or another form of fruit.

4th, A branch to show the mode of growth, the fronds proliferous from near the apex, whence they spring with a short stem.

The habitat is among sponges, *Rytiphlæa pinastroides*, *Nitophyllum laceratum*, &c.

(3.) Fresh and dried specimens of the rare *Codium Bursa*, Ag.

These specimens had all been found by Mrs Merrifield, the authoress of the "Natural History of Brighton," and examined by Professor Harvey of Trinity College, Dublin, who had expressed his opinion as above.

(4.) Many specimens of *Cladophora Merrifieldia*, which, owing to his absence from Britain at the time when the communication describing it was read to the Society, he was unable to exhibit. He remarked that at the time he described it he did not consider it as certainly a permanent form of that very difficult and changeable genus, but that, being more distinct than many species of the genus already described, it was well to note the form. It may be classed under the same category as *Cladophora Gattyæ*, Hass., whose specific claims must, it is to be feared, remain for long *sub judice*.

(5.) *Cladophora glomerata*, Hass.*

Mr Brown also exhibited beautifully carved spoons (made out of a single piece of the sugar maple) from the bazaar of Ispahan, and used by the Persians in drinking their national beverage—sherbet.

Royal Physical Society.

Wednesday, 27th November 1861.—T. STRETHILL WRIGHT, M.D.,
President, in the Chair.

The President gave an opening address, in which, after recording the work of the previous session, and noticing the death of Professor More, and the removal from Edinburgh of Mr A. Murray and Dr Cleland, he remarked;—

Good steady work has been done, and patiently recorded. We are men of work, not of talk. We have given forth no voice on the grand hypothetical questions which are now troubling the commonwealth of Natural Science. We have been singularly apathetic as to whether or no, the stock of our first parent struggled upwards through innumerable adversities from a monad to a man. I fear, indeed, that we are prejudiced people, and would rather leave the question as we found it settled many a year ago at our mother's side. We have given no opinion, as to whether the king of the Gorillas died gloriously advancing on his terror-stricken foe, and beating a far-resounding tattoo on his tympanic chest, or whether

† Brit. Fresh-Water Algæ, i. 213. *Microspora glomerata* (Hass. in Ann. Nat. Hist.) *Conferva glomerata*, Dill. Conf. t. 13.

he was brought to the ground by a rifle-shot in his cerebellum, while ignominiously bolting up a tree. But we have been jotting down hard little facts, rough diamonds, which by-and-by we may see taken up and ground, and polished, and set by other hands,—central points of crystallization, which we may find dotting the pages of great standard volumes, and glimmering from amid the small type of their foot-notes and indices. *Sic tur ad astra.* These small facts are the foundations of adamant on which the vast inverted pyramids of science are balanced. In their discovery they are providential revelations, which, though neglected for ages, may in a moment endow mankind with un hoped for welfare and prosperity. How often have men, dreaming of the transmutation of all metals into gold which would be useless, of the attainment of the Elixir which would confer a dreadful immortality, cast aside the talent placed within their hands, and all that would have made the life ordained for them useful and happy? How often, while invoking all nature to furnish them with the impossible Roc's egg, have they pushed aside the little, dusty copper lamp, which, in return for diligent rubbing, would have invested them with the powers of the genius of Arabian fable! How little did he, who first noticed the attractive property of the loadstone, imagine that to him was revealed a power which would one day guide the commerce and navies of the world over the pathless seas,—which would veer off the floating city, laden with the hopes of a thousand human hearts, and careering over the dark waves with the speed of the wind, from the treacherous iceberg and the crashing floe,—which would link together in the closest bonds all the kingdoms of the earth,—which could correlatively transmute all the forces of nature—and which may one day render the great sea itself one mighty storehouse of fuel and power for the benefit of mankind! How little did he, who first linked together an atom of hydrogen with two of carbon and three of chlorine, dream that then was revealed to mankind the beneficent Elixir which would cause that dread and ancient travail of the woman to cease,—which would change the despairing moan and the agonizing terror of the operating table for a calm and dreamless slumber, and which shall render the fame of Dumas and Simpson undying, until the stream of time shall flow for suffering humanity no more! So it may happen that some unambitious observation made here may throw unexpected light on the geology of our country,—may endow vast districts with mineral wealth undreamt of,—may modify all our received views of cell-life—and put down a hard little point, on which may rise the Physiology and Pathology of the future. Let us therefore go on as we have done, not urged by the desire of fame or notoriety, but constrained by the love of knowledge and truth.

Our Society has still another function. It plays its part as an exponent, through its reports in the daily press, of the progress of Natural Science—a knowledge which cannot fail sooner or later to give a higher tone to the literature and cast of thought of our country. It is painful to notice how the writings of many of the most talented and accepted authors of our day are entirely uninfluenced by the sublime realities of Creation,—realities which excel in their grandeur the most transcendent dreams of the imagination. The poet who prates of “the pale cold moon,” and the “throbbing and pulsing stars,” as the bashful witnesses of some illicit love affair, entertains or feigns an infinitely more degraded conception of his relation to the Universe in which he is placed, than the child who lispeth at evening,—

“Twinkle, twinkle, little star,
How I wonder what you are.”

For that wonder, which accompanies the little one in this his first step to—



wards the attainment of truth, will go hand in hand with him, until in after years he may have sounded all the known depths of the Cosmos. By-and-by he will look upwards to the Firmament in the night season with the astronomer, and see, in the luminous pathway which is extended on high, an awful system of suns—a mist of suns—of whose vast size and distance from each other, numbers fail to impart to the human mind any conception. Each shining particle of that dense sun-cloud, he is told, wondering, is separated from its neighbours by sixty millions of millions of miles. He finds that one such particle alone has been measured, weighed, and analysed ;—it is a vast globe wrapped in a sea of the intensest flame, well-nigh 200,000 miles around ;—that this vast furnace, this infinitesimal particle of sun-mist, is slowly moving across the cloud of its fellow suns ; yet though it should glance with the speed of light for twenty thousands of years, its journey would still be unaccomplished ;—that this almost immeasurable Universe of suns is but a speck in a cloud of grander Universes separated from each other by still more immeasurable wildernesses of darkness extending into infinity for ever. In these unfathomable abysses, he views the wheeling of planets around their sun in slowly rocking orbits,—of suns linked in circling round with their fellow suns, blue, and orange, and green, and crimson,—of Universe linked with Universe,—of immeasurable rings and clusters, and complicated spiral whirlpools, lustrous with countless myriads of suns. But who shall recount to him the unimaginable mysteries of being,—of life, and mind, and soul, called forth by the voice of the Almighty, around each radiant centre !—Who shall report “ their holy triumphs out of evil wrong ! ”—Who shall tell of the great Hosanna, rising throughout these illimitable creations, for ever before the all-pervading mercy-seat of God.

Again, this green duck-pond presents no inviting or miraculous appearance. But the philosopher, still a wondering child, places a drop of its slime under the highest power of the microscope, and a world of beautiful fish-like creatures starts into view,—the green *Euglenas*. He notes the accurate wave-lines of their taper forms,—the long, lashing trunks by which they scull themselves along,—the brilliant crimson eyespeck, which hints of a sense perhaps unknown to man,—the wonderful provision made for their multiplication and preservation,—how a single *Euglena*, by incessant self-division, becomes an infinite host,—how, when the summer sun is drying up the puddle which is its Universe, it seals up itself in a cell of horn, like the Indian Fakir, and lies hard and dry in the mud, or floats a speck of dust upon the breeze, until a welcome shower restores it to liberty and life, when it creeps out of its cell again, not one, but a swarm of little *Euglenas*. The filthy scum, that coats the common sewer, and hangs in long floating fringes from every stick and stone in our Water of Leith, becomes in like manner transformed into vast assemblages of the most wonderful and beautiful of all animalcules,—into forests of *Carchesium*, each animal of which is as a many-branched tree of glass,—each branch instinct with life, slowly extending, or quickly contracting itself in convoluted spirals,—each twig crowned with its vase-shaped zooid, wreathed with a whirling glory of never-resting cilia ; there is the contractile heart ; there the circling round of moving fluids that ceases not but with life. So the vile things of Nature teem with the beauty of invisible existences,—mutter to the attentive ear mysterious life-histories of deeper import than the astronomer's record of all those infinitudes of wandering fire. Each day the sea, slowly creeping back from its weedy shores, calmly reveals unknown and inexhaustible treasures, or, driven into fury by the storm, casts at our feet rarer gems from its deeper store-houses. Each night its waves glitter with sparks of living light, the handiwork of a Providence which never slumbers nor sleeps. Night after

night, o'er all the tide-lashed margins of the deep, the kingdoms of the great Polyp-world blaze before the Lord. All the day long stretch they forth their arms motionless to take their meat from His hand. These, seen but by the seeker, wreathing the worn rocks with garlands of living flowers;—these, towering up from the sombre depths of the Norwegian fiords, lofty as mighty forest trees;—these, clear and tiny as drops of dew, bounding along the surface of the summer seas;—these, slow wheeling like stately argosies, trailing their fringed streamers in graceful spirals many a foot behind;—these, God's workers from the beginning, raising against the Pacific surges vast barriers, before which all the proud erections of man dwindle into insignificance, and which shall endure when the boasted monuments of his religion and his fame shall have crumbled into dust.

Again, our philosopher, still a wondering child, can look back with the geologist, and see "as in a glass darkly," the earth primeval and void, brooded over by the creative spirit of the Almighty. He can view the traces of those mighty elemental wars, those slow millions of years, that lifted the land from the deep;—those slow millions of years, when the early foliage was creeping over its denuded surface, and the unfolding beauties of the radiata and the mollusc received the approving fiat of Him for whose pleasure they are and were created;—those slow millions of years, when the brood of the dragon reigned; when gigantic Saurians trailed themselves through the plashy marshes, darted fish-like through the waters, or, poised on bat-like wings, filled the dank air with bellowing croaks and shrill whistles; there, where ages upon ages afterwards, the wolf howled amidst the dense oak forests of Britain, and snuffed the human holocausts of hordes of naked and painted savages; there, where the well-drained land now whitens yearly with a varied harvest, where the flying express and the electric wire obey the behests of a grave and thoughtful people, where through the summer and autumn time is heard the song of the reaper, and where innumerable church bells proclaim the preaching of the Gospel of Peace. Alas! round each church tower still arises a sad under-song of misery and sin, and borne on the wind comes from the distant ocean the boom of giant instruments of death. Yet, looking back into the past, he can also discern, as in a glass darkly, the future. He can hopefully look forward to that glorious time when, as the old Saurian reign has ceased, so the reptile reign of Sin shall cease, and a renewed race, clothed in the majesty of an innocent manhood, shall lift up their eyes radiant with the indwelling Spirit of the Almighty, and look into the deepest mysteries of God.

Millions of millions of years!—Sad voices cry, "Oh, watchman, what of the night!" "Watchman! will the night of sin never be passed!" But already, those standing on the mountain tops are stretching their hands towards the east. Already, the first glad beams of the World's great day are glancing on their longing eyes. Already, to those waiting in the chill hour before the dawn, is creeping the murmur of innumerable voices as of distant seas awakening 'neath the sun, telling of the slow advance of those beneficent powers which shall make a bloodless conquest of the world, until all its kingdoms shall become the kingdoms of our God and of his Christ.

The mills of God grind slowly, yet they grind exceeding small;

With patience he stands waiting, with exactness grinds he all.

Such are the teachings of Nature;—such the hopes it inspires. In the highest and the lowest,—in the grandest and the meanest,—the perfect working of a perfect God,—ever putting forth through the slowly lapsing ages still nobler manifestations of His Wisdom and His Power. For the present—rest; for the future—unbounded confidence and hope.*

* While these lines are being corrected for the press, Edinburgh is shaken by cannon—booming for a great and peaceful victory. A true and noble man hath

Dr Wright then proceeded with his report on the anatomy of the *Hydroidæ*.

The following communications were read :—

1. *Observations on British Zoophytes.* By JOSHUA ALDER, Esq.

(1.) *Hydractinia areolata*.—*Polypary* encrusting, consisting of a solid chitinous expansion, from which rise simple linear spines in irregular groups, leaving areolar spaces between them. *Polyps*, naked, small, white, columnar, slightly expanding above, and terminated by a conical mouth, below which is a single circle of from six to ten rather slender tentacles, appearing of different lengths from their varying contractibility. Gonophores sessile, large, globular, or slightly pear-shaped, containing each a single medusoid. *Medusoid*, with a moderately deep sub-globose umbrella, with four golden-yellow radiating canals, at the bulbous base of which are four rather short tentacles; four shorter ones alternate with them, and between each again are eight others, almost tubercular. The peduncle is rather long, columnar, white, with four tufts of thread cells surrounding the mouth.

On a small *Natica Alderi*, from deep water, Cullercoats.

(2.) *Atractylis arenosa*.—*Polypary* minute, consisting of a creeping fibre, from which arise short funnel-shaped tubes, rather irregular in form, but always expanding more or less at the top. *Polypes* entirely retractile, with long, slender, strongly muricated tentacles, varying in number, according to age, from six to twelve. The polypary is usually covered with minute grains of sand.

On stones and the roots of *Laminaria*, within tide-marks, at Tyne-mouth and Cullercoats.

Dr WRIGHT stated that he had found this zoophyte at Largo, in autumn last, and had observed its mode of reproduction, which was unique amongst the *Tubulariadae*.

2. *On the Anatomy of Sacculina.* By JOHN ANDERSON, M.D.

3. *On Reproduction in Æquoria vitrina.* By Dr STRETHILL WRIGHT.

In vol. i. of Agassiz's "Natural History of the United States," the following passage occurs:—"As to the *Æquoriadae*, I have no doubt that they are genuine hydroids, though I have not been able to trace with certainty the origin of the *Æquoria* of our coast to any true hydroid. But the structure of *Æquoria* in its adult *Medusa* state is so strictly homologous to that of all the naked-eyed *Medusae*, that even if it were ascertained that it undergoes a direct metamorphosis from the egg to the perfect *Medusa*, I would not hesitate to consider it as a member of the order of *Hydroids*, since it has simple radiating aquiferous tubes, a circular canal, and marginal tentacles closely connected with it, and provided with minute pigment spots at the base." Agassiz was doubtless correct; and he might also have predicted that it belonged to the genus *Campanularia* or

laid aside his titles, and honours, and power; and hath passed from the uncertain and turbulent shadows of this world, to the serene light of the eternal day. Gentle, and wise, and good,—earnest in the work of the present,—he was of those who, standing on the mountain tops, gaze wistfully on the brightening dawn of the future. "*Nobody*," saith he, who being dead yet solemnly speaketh—"Nobody who has paid any attention to the peculiar features of our present era, will doubt for a moment, that we are living at a period of most wonderful transition, which tends rapidly to accomplish that great end to which, indeed, all history points—THE REALISATION OF THE UNITY OF MANKIND. (Speech of the Prince-Consort at the Lord Mayor's Banquet, 1850.)

Laomedæa, as it corresponded with those genera in the presence of otoliths. In the beginning of this month (November) my friend Mr Fulton, to whom I owe so much, sent me two living specimens of *Æquoria vitrina*,—one about three inches in diameter, the other about six inches and a half. The number of lips of the latter was about forty, the radiating canals, each having a long ovisac, about eighty, and the marginal tentacles, by estimation, four hundred. On examining the ovaries, I found that the eggs were hatched, and the young, in the form of almost invisible planulæ, were issuing from the ovisacs. These were gently extracted with a glass syringe, an instrument so useful to those who practise the obstetric art amongst the hydroids, and were placed about three weeks ago in glass tanks of clean sea-water prepared for their reception. Many thousands of larvæ were placed in the tanks, and of those, about a score have been developed into Campanularian polyps, about a hundred are still progressing to that end, and the rest have disappeared. It was with no little impatience and anxiety that I saw the Planula during a fortnight fix itself to the glass, spread itself out into a short thread, secrete its scleroderm, put forth its polyp-bud,—this last slowly swelling day by day, until at last it opened, and a polyp appeared, furnished with twelve alternating tentacles, joined together for about one-third of their length by a web, the polyp enclosed in a cell terminating in many acuminate segments. It is now about six years ago that I was watching in like manner the slow evolution of a bud from a Campanularian Zoophyte, the *Laomedæa acuminata* of Alder,—the Campanulina of Van Beneden,—the bud opened, and a bright green medusoid issued forth, having four lips and two tentacles. The polyp form of *Æquoria vitrina* is, as far as I can determine, identical with that of *L. acuminata* in shape; but is so excessively small,—quite invisible to the naked eye,—that we must wait for further development before we can determine their identity. Geganbaur has proved that the medusoid of *Velella* acquires a further number of canals and tentacles; and I have elsewhere recorded the successive changes which occur in the medusoids of several species of *Atractylis*. It is also certain that such increase in the number of elements does occur in *Æquoria vitrina*, for the smaller specimens have always a less number than the larger. Meantime, the questions as to the larval state of *Æquoria vitrina* is settled. This, the largest of all the naked-eyed Medusas, is the reproductive phase of one of the smallest of all the Hydroids.

Monday, 16th December 1860.—ALEXANDER BRYSON, Esq., President, in the chair.

It was moved by GEORGE LOGAN, Esq., and unanimously agreed to, that, on account of the deeply lamented death of H.R.H. the Prince-Consort, the Society do adjourn to the fourth Wednesday of January.

SCIENTIFIC INTELLIGENCE.

GEOLOGY.

*Coal.**—In the year 1853 a remarkable trial took place at Edinburgh before the Lord-Justice-General and a special jury to try the question

* In anticipation of a full review of Dr Percy's admirable work on Metallurgy, we have quoted the following remarks on Coal, as having reference to questions of interest at the present day.—(Ed. *New Phil. Jour.*)

NEW SERIES.—VOL. XV. NO. I.—JAN. 1862.

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"What is coal?" The owner of an estate had granted a lease of the *whole coal* contained in it. In the course of working, the lessees extracted a combustible mineral of great value as a source of coal-gas, and they realised a large profit by the sale of it as gas-coal. The lessor then denied that the mineral in question was coal, and disputed the right of the lessees to work it. At the trial there was a great array of scientific men, including chemists, botanists, geologists, and microscopists; and of practical gas-engineers, coal-viewers, and others, there were not a few. On the one side it was maintained that the mineral was *coal*, and on the other that it was a *bituminous schist*. The evidence, as might be supposed, was most conflicting. The judge, accordingly, ignored the scientific evidence altogether, and summed up as follows: "The question for you to consider is not one of motives, but what is this mineral? Was it coal in the language of those persons who deal and treat with that matter, and in the ordinary language of Scotland? *because, to find a scientific definition of coal, after what has been brought to light within the last five days, is out of the question.* But was it coal in the common use of that word, as it must be understood to be used in language that does not profess to be the purest science, but in the ordinary acceptance of business transactions reduced to writing? Was it coal in that sense? That is the question for you to solve." The jury found that it was coal. Since this trial the same mineral has been pronounced *not to be coal* by the authorities of Prussia, who accordingly have directed it not to be entered by the custom-house officers as coal.

From what precedes, it is evident that it is not easy to frame a precise definition of the term coal, either in a commercial or in a scientific sense. The substances to which the term coal is usually applied differ widely both in physical and chemical characters. All coal results from the decomposition of vegetable matter under special conditions, and in degree of decomposition there is every stage. Thus, at one extreme is lignite, some varieties of which closely resemble wood both in composition and appearance; and at the other is anthracite, which consists almost wholly of carbon, and is, in all respects, unlike wood. Again, the proportion of earthy matter, or ash, in coal is subject to great variation. Suppose a mineral to consist of 5 per cent. of coal-like, black, combustible matter, in all respects similar to undoubted coal, and of 95 per cent of earthy matter. No one would designate such a mineral as coal. Then the question arises, What is the *maximum* amount of such matter which can exist in coal? No definite answer can be given. In the present state of science, I do not believe it possible to propose an exact definition of the term coal. Geological position does not afford satisfactory grounds for a precise definition; for the mineral which was the subject of investigation at the trial in Edinburgh occurs in association with coal of the true Coal Measures; and true coal, so far as may be inferred from the assemblage of chemical and physical characters, is met with in other and more recent geological formations. Perhaps the nearest approach to a definition would be the following: Coal is a solid mineral substance, more or less easily combustible, varying in colour from dark brown to black, opaque—except in extremely thin slices—brittle, not fusible without decomposition, not sensibly soluble in ether, benzole, chloroform, or turpentine—not containing sufficient earthy matter to render it incapable of being applied with advantage as a source of heat in ordinary fire-places or in furnaces. This would exclude amber and other resinous matters, bitumen, and bituminous schists when they contain so large an amount of earthy matter as to be incapable of being employed as fuel; and, I think, it would also exclude even the most compact varieties of peat, none of which can be properly considered as brittle.

My friend Dr Bennett has proposed a definition of coal founded on the appearance, under the microscope, of certain rings in a well-made transverse section; and he maintains that by means of this appearance all kinds of coal, whether household or cannel, can at once be distinguished from the Torbanehill mineral. I do not, however, find that this distinction has been accepted by histologists. Dr Bennett repudiates the verdict of the Scotch jury. He writes, "At the trial it was very plausibly argued that, in a bargain between man and man, scientific truths were of no value, and that a whale among whalers was still a fish. But as no naturalist, conversant with the structure and functions of a whale, would for a moment suppose it to be a fish because it inhabits the water and resembles one, so, I contend, no histologist acquainted with the structure and properties of the Torbanehill mineral ought to maintain that it is coal because it is dug out of the earth and burns in the fire."

Whatever difference of opinion there may be respecting the mode of accumulation of the great deposits of coal,—whether these deposits have, like peat, been produced *in situ*, or whether they have been derived from drift-wood,—there can be no doubt that coal, as has been previously stated, is the product of the decomposition of vegetable matter under special conditions. If we study the analyses of coals, we can readily select a series which illustrates the gradual passage of woody tissue into anthracite, or that variety of coal which consists almost wholly of carbon. Such a series is presented in the following tabular form, the proportion of carbon being estimated at the constant amount of 100:—

	Carbon.	Hydrogen.	Oxygen.
1. Wood (from mean of analyses 1—26)	100	12.18	83.07
2. Peat	100	9.85	55.67
3. Lignite, average of 15 varieties.....	100	8.37	42.42
4. Ten-Yard coal of the South Staffordshire basin..	100	6.12	21.23
5. Steam coal from the Tyne	100	5.91	18.32
6. Pentrefelin coal of South Wales.....	100	4.75	5.28
7. Anthracite from Pennsylvania, U.S.....	100	2.84	1.74

From this it will be perceived that through these various stages of conversion the proportion of carbon relatively increases, while that of the hydrogen and oxygen decreases.

If we examine the relation between the hydrogen and oxygen in these successive degrees of conversion, we shall find that, with the exception of anthracite, there is a steady increase in the proportion of hydrogen beyond that required to form water with the oxygen present. The following numbers express this gradual increase in the excess of hydrogen:—

	Hydrogen.		Hydrogen.
1.	1.80	5.	3.62
2.	2.89	6.	4.09
3.	3.07	7.	2.63
4.	3.47		

The formation of these products of the decomposition of woody tissue may be explained by the elimination of hydrogen in combination with carbon as *marsh-gas*, of oxygen in combination with carbon as *carbonic acid*, and of hydrogen in combination with oxygen as *water*. That the derivation of coal from woody tissue has been accompanied with the evolution of marsh-gas, might be inferred from the nature of the gases generally occurring in coal-mines, of which that gas is the chief constituent. However, the hydrogen and oxygen are never completely separated, as these elements are always present in sensible proportion in anthracite, which is furthest removed from woody tissue in composition.

Nitrogen is always found in coal, and its proportion seems to range pretty constantly between 1 and 2 per cent. Although nitrogen does not appear to be an essential element of woody tissue, yet that tissue is always associated with nitrogenous matters, so that the source of nitrogen in coal is readily accounted for. Hence ammonia is generated in the dry distillation of coal, and the product is consequently alkaline. In the dry distillation of woody tissue, on the contrary, the product is acid, owing to the presence of free acetic acid.

Sulphur is always present in coal. It may exist in the state of sulphuric acid in combination with a base; in combination with iron as iron pyrites or bisulphide of iron; and probably also in combination with the organic elements of coal as it exists in albumen. It chiefly occurs in the state of iron pyrites. In the dry distillation of coal a portion of it is evolved partly as sulphuretted hydrogen and partly as bisulphide of carbon.

All coal contains a greater or less proportion of water, which may be expelled at or slightly above 100° C. A coal may appear perfectly dry, and yet lose by desiccation a very large amount of water; as much even as 20 per cent. Whether the water exists wholly as hygroscopic water, or whether, in some cases, it may not be partially combined, is doubtful; yet facts will be advanced in the sequel which seem to support the latter view. The amount of water which may remain in some varieties of coal, even after desiccation by free exposure to the air, deserves more attention than it generally receives from metallurgists.

All coal contains a sensible amount of inorganic matter, of which the chief constituents are silica, alumina, lime, and iron. It is this matter which appears as the ashes of coals. Now, admitting that alumina is not an ordinary constituent of plants, it follows that the matter of which the ashes are composed has been derived not merely from the inorganic elements originally existing in the plants from which coal has been produced, but also from an extraneous source. When we consider the conditions under which coal must have been formed, we can be at no loss to understand how such extraneous matter should have been deposited in a coal-field by the agency of water. We have only to inspect a coal-seam to have ocular and positive proof of the interstratification of coal and earthy matter such as shale and sandstone. In illustration, we may take the familiar but extreme case of blackband ironstone. This ironstone consists essentially of carbonate of iron intimately mixed with coal. If further proof were needed of the admixture of coal with such extraneous matter, it is furnished conclusively by the results of Taylor, who has analysed the matter forming the bed and the roof of a coal-seam at Newcastle (*Buddle's Hartley and Blaydon Burn Colliery*), as well as the ashes of the intervening coal. The analyses are as follow:—

	1.	2.	3.	4.	5.
Silica	62.44	59.56	64.21	56.51	58.99
Alumina	31.22	12.19	28.78	31.89	26.19
Sesquioxide of iron..	2.26	15.96	2.27	...	5.14
Protoxide of iron...	.. .....	.. .....	.. .....	7.04	5.11
Lime	0.75	9.99	1.34	1.69	0.67
Magnesia	0.85	1.13	1.12	0.85	1.54
Potass	2.48	1.17	2.28	1.38	2.34
Soda .....	.. .....	.. .....	.. .....	0.61	...
	100.00	100.00	100.00	99.97	99.98

1. *Fire-clay*, on which the coal rests, after subtraction of 10.5 per cent. of water and 0.44 per cent. of chloride of sodium and sulphate of soda.

2. Ashes of *good coal* (1·36 per cent.), after subtraction of 8·2 per cent. of sulphuric acid. The source of the sulphuric acid will be explained in the sequel. 3. Ashes of the *coarse coal* (16·9 per cent.), after subtraction of the sulphuric acid. 4. *Bituminous shale*, after subtraction of 39·85 per cent. of organic matter. 5. *Bluish shale*, after subtraction of 11 per cent. of water.

Ashes of coal.—In the choice of coal, attention should be directed to the *nature* as well as the *proportion* of the ashes which it may yield. The proportion may be so great as to lessen its value in a very material degree, or even to render it useless as a fuel for many purposes. It may be determined by incineration at a red heat in a platinum or porcelain crucible. The process may be conveniently conducted either over an air-gas flame or in a muffle. In respect to the *nature* of the ashes, the amount of oxide of iron is a point of chief importance. Iron pyrites is present in all coal, in which it may occur either invisibly diffused through the mass,—in visible laminae,—or in layers and nodules, sometimes of considerable size. The spontaneous combustion of coal in coal-mines appears to be due, in part at least, if not wholly, to the heat developed by the oxidation of intermixed pyrites by atmospheric air. When some kinds of coal are left exposed to the air, yellow spots will eventually appear here and there on the surface, which consist of basic sulphate of sesquioxide of iron (misg) derived from the oxidation of pyrites. At first, sulphate of protoxide is formed, of which the quantity is occasionally so great as to cause complete disintegration of the coal. The water which flows from coal-mines frequently contains in solution sufficient sulphate of iron to communicate a strong chalybeate taste. Such a solution rapidly corrodes iron boilers, and, by free exposure to the atmosphere, will deposit a yellow-brown ochreous compound of basic sulphate of sesquioxide of iron. Shale, which consists essentially of silicate of alumina, is generally present in coal in a greater or less degree, as will appear from the analyses of the ashes of coal; and when it is in contact with iron pyrites in process of oxidation by exposure to the air, it may give rise to the formation of iron-alum in white asbestiform fibres. The formula of this beautiful substance is $\text{FeO}, \text{SO}_3 + \text{Al}_2\text{O}_3, 3\text{SO}_3 + 24\text{H}_2\text{O}$.

The iron pyrites in coal will be represented in the ashes by an equivalent amount of sesquioxide of iron, provided incineration be perfect; and generally by far the greater portion of the oxide of iron in the ashes is derived from pyrites. The proportion of that oxide may be sufficient to give a red colour to the ashes, or it may not be sufficient to cause sensible coloration; hence the distinction between *red* and *white ash* coals. The intensity of the red colour, taken in connection with the amount of ashes in coal, may serve as an indication of the proportion of sulphur existing in the state of pyrites. When a coal contains pyrites in considerable quantity, especially in the state of nodules, it may speedily destroy the fire-bars of a furnace. In one instance in which a highly pyritic coal was employed in a reverberatory furnace, I observed ferruginous masses depending like stalactites from the lower surface of the bars, which were rapidly corroded in consequence. When the ashes sinter together or melt, they form a more or less vitrified mass termed *clinker*, which may accumulate upon the bars so as greatly to impede the passage of air between them, and, as a consequence, lower the temperature of the furnace. Moreover, when the bars are covered with a firmly-adherent bed of clinker, and are no longer cooled by a continuous current of cold air, they may soon become heated and destroyed by oxidation. Now, the presence of much oxide of iron in the ashes may, in a certain degree, increase their fusibility, and so tend to induce the evil arising from the formation of an impervious bed of clinker. In this case a greater expen-

diture of manual labour would be required in removing clinkers, or, as it is termed, *clinking* the grate. But sometimes a bed of clinker is expressly formed, and made to serve an important purpose. Thus, in furnaces in South Wales such a bed is ingeniously used as a substitute for a grate, on which small and inferior coal may be consumed, which could not be otherwise profitably applied. The bed is allowed to become 12 or 20 inches thick, and requires to be supported only by a few bars, which, being far removed from the fuel, remain comparatively cool. It is kept broken up, so that a sufficient quantity of air may traverse it; and, in proportion as it accumulates above, it is cut away underneath by means of a crowbar with a cutting edge and a heavy hammer. This operation is termed *breaking the grate*. However, as a rule, the less a coal clinkers the better for most purposes, and for none more so than boiler-furnaces. Irrespective of the formation of clinker, a certain amount of inorganic matter in coal is sometimes beneficial in preventing the fire from too rapidly collapsing, as it were, in the furnace. On this account a kind of coal called *brasils*, which occurs in the middle of the ten-yard coal in South Staffordshire, is preferred for reverberatory furnaces by some smelters in Birmingham.

Errors in analysis of coal.—When coal contains much inorganic matter, especially iron pyrites, the usual method of calculating its composition from the data obtained in the process of organic analysis may be erroneous in a sensible degree. The ashes left by incineration are estimated as inorganic matter, and the proportion of oxygen is found by subtracting the sum of the carbon, hydrogen, nitrogen, and ashes from the amount of dry coal subjected to analysis. By incineration the iron of the pyrites is converted into sesquioxide, and the sulphur, in a greater or less degree, into sulphuric acid, which may remain in combination with any base in the ashes—such as lime—capable of forming a sulphate not decomposable at a red-heat. Supposing the whole of the sulphuric acid to be thus retained in the ashes, for 1 part of iron pyrites there would be an increase of 1 due to oxygen derived from the air during incineration. The whole amount of this error, provided no correction be made, would fall upon the oxygen. It is not asserted that the whole of the sulphur is actually converted into sulphuric acid and retained in the ashes, but that a considerable portion of a stable sulphate may be produced during incineration will appear from analyses of coal in the sequel. It is certain that the alumina in the ashes must in great measure exist in combination with silica as clay; but clay holds water in combination which cannot be expelled except at a temperature far more than sufficient to decompose coal. Hence, during the process of organic analysis water may be evolved from the clay present in coal, and so occasion an error of excess in the determination of the hydrogen. This source of error has been pointed out by Regnault. Carbonate of lime is sometimes present in coal in very appreciable quantity, in which case carbonic acid would be evolved during the analysis, and so an error of excess would be caused in the determination of the carbon. M. de Marsilly has observed that, however pure a piece of coal may be, and however homogeneous it may appear to the eye, its different parts do not yield the same proportion of fixed residue by incineration; and the same is true in respect to the proportion of coke obtained by the calcination of different fragments of the same lump of coal. Hence, in every case, the proportion of ash and coke should be determined by operating upon an average sample taken from the powder of the coal.

Lignites.—The synonyms are brown coal, bituminous wood, and pitch-coal of Werner (Pechkohle). Geologists apply the term lignite only to those carbonaceous minerals which occur in deposits of later date than

the true Coal Measures; and yet these minerals may occasionally not be distinguishable, either in physical characters or chemical composition, from undoubted bituminous coal. However, the cases in which lignites thus resemble bituminous coal are exceptional. Lignites seem generally to differ from other kinds of coal in the *large proportion of water* which they retain, even after free exposure to the atmosphere at the ordinary temperature. They appear to pass by insensible gradations into bituminous coal; and at present it seems impossible to construct a definition, except on geological grounds, which shall be characteristic of lignites alone, to the exclusion of all other kinds of coal. For the sake of convenience, some varieties of coal which occur in formations posterior to the Coal Measures, and which approximate closely to, if they are not identical with, certain kinds of bituminous coal, will be classed among the lignites proper. Moreover, an illustration will thus be afforded that true coal, so far as relates to composition and external characters, is not confined to the Coal Measures.

Lignite is either wood-like in structure, earthy, or compact; fracture conchoidal, wood-like, or uneven; colour of various shades of brown, brown-black, or black; lustre dull, shining or fatty; specific gravity generally ranges from 1.2 to 1.4; in composition it approaches nearer to wood than bituminous coal, and is specially distinguished from other kinds of coal in retaining a large proportion—from 15 to 20 per cent. or more—of water, even after desiccation by long and free exposure to the atmosphere at the ordinary temperature. Lignites are generally non-caking,—that is, the powder of lignite, when heated to redness in a close vessel, does not yield a coherent coke. The term lignite is restricted by some persons to such varieties as manifestly present the appearance of woody tissue, the term *brown coal* being applied to all other varieties. Brown coal is the term at present used by the Germans as including all varieties, whether woody, earthy, or compact.—“*Metallurgy*,” by John Percy, M.D., F.R.S.

Fossil Plants in Coal-Beds of Arkansas.

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| 1. Alethopteris nervosa, Brgt. | 20. Lepidodendron diplolegiodes, Sp. nov. |
| 2. Alethopteris Owenii, Sp. nov. | 21. Lepidodendron modulatum, Lsqx. |
| 3. Annularia spheophylloides, Ung. | 22. Lepidodendron vestitum, Lsqx. |
| 4. Asterophyllites equisetiformis, Sternb. | 23. Lepidophloios irregulare, Sp. n. |
| 5. Asterophyllites gracilis, Sp. nov. | 24. Lepidophyllum brevifolium, Lsqx. |
| 6. Blattina venusta, Sp. nov. | 25. Lepidophyllum lanceolatum, Brgt. |
| 7. Bornia? Sp. nov. | 26. Lepidophyllum, leaves of Lepidodendron. |
| 8. Calamites approximatus, Sternb. | 27. Lepidophyllum majus, Brgt. |
| 9. Calamites cruciatus, Brgt. | 28. Neuropteris fimbriata, Lsqx. |
| 10. Calamites undulatus, Sternb. | 29. Neuropteris hirsuta, Lsqx. |
| 11. Cardiocarpon affine, Sp. nov. | 30. Neuropteris tenuifolia, Brgt. |
| 12. Cardiocarpon ingens, Sp. nov. | 31. Neuropteris vermicularis, Lsqx. |
| 13. Carpolithes platimarginatus, Lsqx. | 32. Odontopteris intermedia, Sp. nov. |
| 14. Cordaites borassifolia, Ung. | 33. Pecopteris villosa? Brgt. |
| 15. Cyclopteris (broken specimen). | 34. Rhabdocarpos minutus, Sp. nov. |
| 16. Diplogium truncatum, Sp. nov. | 35. Rhizolites palmatifida, Sp. nov. |
| 17. Halonia pulchella, Sp. nov. | 36. Sigillaria reticulata, Sp. nov. |
| 18. Hymenophyllites flexicaulis, Sp. nov. | |
| 19. Hymenophyllites, Sp. nov. | |

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| 37. Sigillaria, Spec. nov. | 42. Sphenopteris decipiens, Lesq. |
| 38. Sphenophyllum bifurcatum, Sp. nov. | 43. Sphenopteris Gutbieriana, Germ. |
| 39. Sphenophyllum longifolium, Gutb. | 44. Sphenopteris obtusiloba, Brgt. |
| 40. Sphenophyllum Schlotheimii, St. | 45. Staphyllopteris stellata, Sp. nov. |
| 41. Sphenopteris dilatata, Sp. nov. | 46. Stigmaria flooides, Brgt. |
| | 47. Stigmaria irregularis, Lesq. |
| | 48. Stigmatocanna? |

From a view of this table, the following conclusions can be drawn. That of forty-eight enumerated species, eighteen are new, and consequently have not been found above the Millstone Grit. Two more, represented by broken specimens, are perhaps new also, and thus 26 to 28 species of the Arkansas coal have been found before in strata of coal above the Conglomerate formation at other places in the United States coal-fields. I doubt not that if we had had a whole day to spend at Male's coal-bank instead of an hour, we would, with the assistance of Mr Cox, have collected at least a dozen other new species. But the number of old and already known species would have been greater also, since in a hurried examination I could note only the most marked species which were seen. Therefore the coal plants of the Male's bank may be considered as presenting in a fair average the proportion of old and new species of plants pertaining to the coal-beds below the Millstone Grit. Admitting this, I do not think that this proportion of new species of plants of the Arkansas Coal Measures authorises a separation of these Measures from the beds above the Conglomerate; permitting the distinction of another name (that of *false coal-measures*), as if they were a peculiar formation.

New discoveries of fossil plants by the Geological State Survey of Illinois show the proportion of large trees increasing as far down as below the Upper Archimedes Limestone, where a thin bed of coal is sometimes present, as at Fayetteville. Nevertheless, the plants of this low position are still of the same genera as those of the true Coal Measures, and half of them, at least, have the same specific characters. Thus, it is evident that the true Coal Measures descend as low as the Subcarboniferous Limestone, and even can be counted to the second bed of the Archimedes Limestone. Not much coal is formed there, it is true, but it is the beginning, the infancy of the epoch, which, as at the time of its decrepitude and near its end, has the strata of combustible matter scarcely formed and thin.

It is impossible now to establish a close comparison between the strata of the Old Red Sandstone of Pennsylvania and the Subcarboniferous Limestone of the West, which, following the assertion of some geologists, occupy its place. From some data formerly collected, the Red Sandstone of Pennsylvania had very few species, if any, identical with those of the Coal Measures. It is characterised especially by the species of true *Noeggerathia*, which have never been found in connection with the coal, and which I have found in abundance in the red shales immediately underlying the conglomerate formations of Mauch Chunk and Pottsville, and lower still.

It would be even more difficult to compare the distribution of the plants of the Coal Measures and of the New Red Sandstone or Permian overlying them. The Permian is scarcely known in America, and no plants have been found in it. But in Europe, the proportion of the vegetable species common to the Permian and the Coal Measures is no more than eight per cent, while between the Subconglomerate coal and the Coal Measures above the Conglomerate, the proportion of common species is from fifty to fifty-five. Moreover, with the appearance of the

Permian, a number of entirely different typical forms, mostly *Coniferae* (*Aracocarites*, *Walchia*, *Pinites*, &c.), appear at once; and these forms having no relation whatever to the genera of plants of the Coal measures indicate a new epoch in the vegetation. Thus it is certain, that if we should separate, as some geologists have done, the Subconglomerate coal as a peculiar formation, we would do it against the general laws of distribution of the species, and would be forced to consider each peculiar bed of coal as a separate formation, or rather as an epoch.

The other conclusions taken from the examination of the table are in favour of the horizontal identity of all the coal strata of Arkansas, the apparent difference in their species resulting from the small number of fossil plants which have been found at some localities. Thus the coal of James' Fork of Poteau where, after Male's coal-bank, the largest number of fossil plants were seen, has, in twenty-five species, ten species in common with Male's coal, some of which are new and apparently truly characteristic of the subconglomeratic coal. Of ten species collected at Jenny Lind coal-bank, eight were seen also at the James' Fork of Poteau. Seven of the eight species of Lee Creek coal have been found also at Male's, and of eleven fossil plants found in the shales at Frog Bayou, seven belong also to Male's coal-bank. Taking into consideration the insufficiency of the researches and the distance of the coal-banks where the plants were found, it is easily admitted that this approximate identity of species shows with great probability, if not with certainty, that the coal-banks or strata reported above are to be placed on the same geological horizon.

The Lignite formation is easily distinguished from the Coal Measures, as well by its distribution, its geological position, the chemical compounds of its combustible matter, as by the plants by which it is accompanied. From the few data which have been collected in Arkansas it appears that the lignites of that State are found generally near the base of the Tertiary measures. They have been formed by an accidental deposition of a certain quantity of wood, apparently transported by rivers or some other agency, or even, perhaps, are composed of the heaped remains of trees which grew in marshes and swamps at the place where beds of lignites are now found. The areas which they cover with strata of combustible matter is extremely variable. Sometimes they extend themselves for hundreds of miles, preserving a constant horizon; sometimes they have only a few feet in diameter, and appear either thin or like a broken and heaped compound of combustible black matter, irregularly placed at various horizons in the same vicinity. Beds of Lignites are generally intermixed with clay or sand. Their overlying strata are not shales, but mostly soft, black or yellow plastic clay or sand. The numerous remains of plants found in this soft matter are of course decayed, broken, and undistinguishable.

The only bed of Lignites which I had an opportunity of examining in Arkansas is exposed on Little Cypress Creek, Dallas County, on the property of Mr. Watson. It crops out on the nearly perpendicular and much disturbed bank of the creek, is one to two feet thick, sometimes black and a compound of pure combustible matter much softer than stone coal or true coal, sometimes formed of alternate layers of soft clay with bands of black and pure lignite, from one to two inches thick. There are apparently two beds of lignite exposed on this bank. The one, nearly at the top of the bank, is overlaid by one foot of black soft clay covered with about twenty feet of argillaceous sand. The other exposed a little lower down the creek appears separated from the former by nine feet of soft plastic clay without plants. As the bank has been much disturbed by the erosions of its soft parts, which have caused slips and local sub-

idences, it is still possible that there is only one bed of lignite formed there, parts of which have accidentally been broken off and dropped down the declivity of the bank.

In counties where wood is still abundant, beds of tertiary lignites are perhaps, for the present, of no great value. Nevertheless, when the combustible mineral is pure, the amount of carbon which the matter contains is always greater than it is in wood. Following the analysis of two specimens of lignite of Green County, the amount of carbon in the matter is fifty-three to fifty-seven per cent., when the carbon of wood does not amount to more than forty to forty-five per cent. Thus these beds of lignites may become valuable in the future, especially for the navigation of the steam-boats on the rivers.

As beds of lignite found in the south-eastern part of Arkansas have been taken sometimes for strata of true mineral coal by persons unacquainted with the distribution of the geological formation, it is well to present in a single table, and for comparison, some of the fossil leaves which are generally found in connection with these beds of recent origin. All the leaves found fossil in the Tertiary, recall forms which we are in the habit of seeing around us on the trees of our time. Most of the genera, even some of the species, are the same. Thus we have with the lignitic formation fossil leaves of the oaks, walnuts, beeches, magnolias, elms, and others; mostly leaves of Dicotyledonous trees, easily recognised by the branching of the veins. On the other hand, the fossil leaves of the true coal are mostly ferns, and the other remains represent the scars on the striæ of the bark of trees of which the form, the direction, and the remarkable regularity is entirely at variance with the rough and irregular surface of the bark of our trees.—*Geological Reconnoissance of Arkansas*, 1859 and 1860, by David Dale Owen.

Sub-Himalayan Rocks.—Pointing out briefly how, from the abundance of the fossil evidence, the Siwalik strata had at once taken their position in the acknowledged series of rock-formations, while very little indeed was known of their physical structure; and how at the same time other groups of Indian rocks, whose stratigraphical relations were well known, had not as yet been accurately placed in the general succession, owing to the absence of such fossil evidence, Mr Medlicott stated that his own attention had been specially directed to investigating the physical structure of the district referred to, not to the collection of fossils.

The rocks included are the Siwalik and the Nummulitic groups, and a series of schistose rocks older than both these, and lying to the north of them. The present notice was principally concerned with the newer groups (the Upper Nummulitic and the Siwaliks), the separation of which from the lower and more indurated underlying strata is generally well defined.

Up to the present time our knowledge of these groups was as follows. The most connected sketch hitherto given is by Captain R. Strachey (*Quar. Jour. Geol. Soc. London*, vol. vii. p. 292, 1851). This paper chiefly related to the rocks of the higher ridges and of Thibet, but the author refers also to the fossiliferous rocks at foot of the range. The section, given by Captain Strachey, passing through Nainee Tal, shows but a very bad development of the Siwalik rocks, and he could nowhere "find or hear of any fossil remains among them." He assumes them, however, to be the representative of the rocks near Dehra. He then proceeds to notice a series of sandstones, with occasional small seams of lignite, and imperfect vegetable impressions, and with beds of marl, and occasionally salt-springs, which form the northern boundaries of the longitudinal valleys, or duns, the connection of which with the outer Siwaliks he could not trace, but conjectured that there must be great faults. Suggestions were thrown

out that these might be of the European Saliferous age, or possibly the extension of the strata containing rock salt which are found farther to the west in the salt range and in the hill district of Mundee. It was also suggested, as possible, that they might have some connection with the fossiliferous beds near Subathoo. In 1853 a brief notice of the rocks about Subathoo, by Major Vicary, appeared (*Quar. Jour. Geol. Soc. London*, vol. ix. p. 70). In this paper the author noticed the true Siwalik rocks, south of the Pinjore Dun, and also a sandstone not unlike that of the Siwaliks, in the north of the dún in which he had sought for fossils in vain. The connection of this with the outer Siwaliks is concealed. North of this we meet with confused strata of variegated shales, also unfossiliferous. On the ridge of Kussowlie, and beyond it to Subathoo, the fossiliferous rocks of the Nummulitic period show, associated with variegated rocks, &c. These are made subjacent to the fossiliferous strata. All these groups Major Vicary separates from the Simla series by a great fault. Regarding the age of these older and inner rocks, neither Major Vicary nor Captain Strachey offer any conjecture.

In M. D'Archiac's valuable treatise on the Nummulitic fossils of India, Major Vicary's section is copied, and he is quoted as the authority for other statements. In these there is an important discrepancy or error which must be noticed. M. D'Archiac speaks, in the most unequivocal manner (pp. 175, 176), of mammaliferous strata, representatives of the Siwalik formation, about Subathoo, and there overlying the Nummulitic rocks. Inasmuch as Mr. Medlicott's own researches had pointed out that the strict limitation of those fossils to the "Siwalik hills" is one of the most interesting facts in the geology of the district, he devoted repeated examination and inquiry on the spot to investigating these statements, but he could find no trace of such fossils; nor could he reconcile M. D'Archiac's statements with Major Vicary's published account. Possibly the explanation of the difference is this: Major Vicary does mention fossil bones at and near to Subathoo; he says, "Saurian remains are, however, plentiful; I am not so sure with respect to mammalian remains, but, as the specimens are in good hands, I hope soon to settle that point." These remains, however, he in every case describes as occurring in blue or red shales alternating with or underlying Nummulitic strata. Without in the least questioning Professor Owen's skill in identifying genera from obscure remains, Mr Medlicott was forced to think Major Vicary far too experienced and too intelligent a collector, to have failed in recognising as mammalian such abundant remains as are mentioned by M. D'Archiac—"Elephas, equus, bos, cervus, &c., des debris de dent d'un elephant mastodontoide," and other similar statements. A clue to the explanation is to be found in M. D'Archiac's own words—that the sands, gravels, and conglomerates with bones of large mammalia, rest quite conformably on the Nummulitic beds near Subathoo (p. 176). Now, there is not even an allusion to such rocks by Major Vicary; on the contrary he says, "The blue shale, on which the quarter-guard of Subathoo stands, contains fossil bones in abundance," and so in other cases. In truth, there are no such rocks at Subathoo as those spoken of by M. D'Archiac. Such rocks are unquestionably the common habitat of Siwalik fossils, and it is not improbable that, in consequence of original deficient labelling of specimens, and possibly of subsequent intermingling, or, in consequence of a misunderstanding of written or verbal communications, some true Siwalik fossils were mistaken as coming from near Subathoo.

Mr. Medlicott's own researches, extending over a direct distance of more than two hundred and fifty miles, from the parallel of Nainee Tal to beyond the Sutlej, led him to expand considerably the series of rocks which were known to occur within these limits. This, for the present,

could be most conveniently done under the two groups already known, viz the Nummulitic and the Siwalik. Of these groups the latter is continuous beyond the limits of the area examined; the former are much more irregular. The Upper Nummulitic group does not even reach the Jumna on the east; while on the west also its continuity is interrupted, though not permanently.

Thus the connection suggested in Captain Strachey's paper and map between the lignite sandstone, N. of the Kotah Dún, and the fossiliferous sandstone of Subathoo, is not established. The Kotah Dún rocks really correspond to the Siwalik-like sandstone, N. of Pinjore Dún, in Major Vicary's section.

Between the two groups the most decided physical separation exists, a fault of enormous throw, amounting to the entire thickness of the two series, cutting off the Siwalik group from all to the north of it. To the east of the river Jumna this great fault runs at a variable elevation along the flank of the hills lying to the north of the duns; the rocks, in junction on the north, being the limestones, slates, and grits of the Lower Nummulitics and of the undetermined subjacent rocks—the Masuri or Nainee Tal series; while to the west of the Jumna, the rocks in junction are generally these same schistose rocks, but often, especially at higher levels, the Upper Nummulitic series.

North of this fault there is not so decided a boundary; the junction of the Upper Nummulitic series with the slaty series, lying to the north of it, is not (though so represented) a great fault. There is, undoubtedly, considerable local faulting; but, generally, the junction appears to be the original contact of deposition between unconformable strata. The Upper Nummulitics, in fact, seem to rest upon a ledge of the slaty rocks, upon a denuded surface of which they had been deposited.

There is a most marked geological separation to be made in the series spoken of as Nummulitic, upper and lower. Of the lower group, the best and least disturbed section is at the Król mountain on the new road to Simla. At this locality there is a well-defined series (from 500 to 800 feet) of hard limestones with variegated slaty shales and grits, which may be called the Król group. It rests, unconformably, upon a great thickness of very thin bedded slaty shales and gritty flags, often highly carbonaceous and black, which may or may not prove to be a member of the lower Nummulitic series.

The upper sub-division of the Nummulitics is best seen near Subathoo, and gives three sub-groups in descending order:—

1st. Sandy—hard sandstones largely predominate; well exposed in Kussowli hill. In this group (at Kussowli and elsewhere) some well-preserved leaves and stems of trees, and other remains of terrestrial vegetation, have been found.

2d. Sandy-argillaceous—lumpy sandy red clays. These are characteristically seen in flanks of Dugshai hill.

3d. Calcareo-argillaceous—well seen near Subathoo. These are all connected by conformity in stratification, and by transition in mineral character, and form one continuous sequence. They may be called the *Subathoo group*.

In rocks so contorted it is difficult to estimate thickness, but 1800 to 2000 feet may be given as the minimum.

All fossils hitherto procured have been from the lower half of this series, as seen near Subathoo.

The beds of this upper or Subathoo group are often found folded into the contortions of the Król group and the subjacent slates—Król and Bóí mountains, &c.

This Subathoo group is entirely distinct, as shown, from the band of

limestones and slaty clays long known to extend along the southern border of the western Himalayas. It does not appear to extend to the east of the Jumna, at least no trace of it is seen between the Jumna and Nainee Tal.

The separation we have made here from stratigraphical considerations was in a manner anticipated by D'Archiac from a consideration of the fossil evidence alone; at least he pointed out the entire distinctness of the organic remains of Subathoo as compared with those of the Punjab, of Scinde, of Beloochistan, and of Cutch (p. 175). But in the concluding section of this description (p. 179) where reasoning on the very uncertain observations of others, he is far from correct in stating that no appreciable unconformity could be observed between the two, or indeed between the Nummulitic strata generally and the overlying Siwalik series.

The evidence for supposing the Król group, as given above, to be also of Nummulitic age, is not perfectly conclusive. Mr A. Schlagintweit has announced the discovery of Foraminifera in the neighbourhood of Nainee Tal, "identical with those which accompany the Eocene Nummulitic formation," and those rocks at Nainee Tal are considered by Mr Medlicott to be the true representatives of the Król beds; but independently of this, the conclusion was arrived at from observations in the salt range, and in the Himalayas of Huzara and Poonch.

There is a great similarity in the section about Murree and north of Kotlee in the Kashmir territory, to that at Subathoo. Three or four miles north of Kotlee there is a stony rib of hard limestone, with an E.S.E. direction; on both sides of this are brown clays and lumpy earthy limestone of the same character as the Subathoo rocks, succeeded by a great thickness of red clays and hard limestones; in fact, the series called above the Upper Nummulitic. These rocks are noticed by Mr Schlagintweit, "To the south of Kashmir a zone of Nummulitic marls and of sandstones, of thirty-nine to fifty miles broad, borders the Himalaya towards the plains of India." The relations of this series to the massive limestone ridge are precisely the same as with the Król limestone; the ridge at Dundee being altogether analogous to the rib thrust through the Nummulitic strata at Dihur on the Sutlej; the resemblance lithologically is also perfect. Again, Murree stands on a mountain of red clays and sandstones; the Mochipora ridge to the N. and N.W. of it is of the hard limestone, and along the junction Nummulitic rocks, identical with those at Subathoo, are easily traceable, although not well developed. In this hard sub-crystalline, and generally unfossiliferous limestone of the Mochipora ridge, Nummulites have been found, as already noticed by Dr Fleming (Quar. Journ. Geol. Soc. London, 1853, p. 200). On passing to the salt range, this Subathoo series was found to be entirely wanting, although so largely developed to the north. In the salt range, the thick soft sandstones and variegated clays of the Siwalik formation rest directly on the clear Nummulitic limestones, as noticed by Dr Fleming; the very junction layers containing only rolled Nummulites. But there is nothing, at least in the east of the range, to represent the Subathoo group. There is nothing, either, to suggest the idea that these can be assimilated to the salt range Nummulitic rocks; on the contrary, all stratigraphical and mineral affinities of the Subathoo group are with the Siwalik type rather than with that of the salt range Nummulitic strata. These latter appeared to be more probably the representatives of the great limestone deposits which were found all along unconformably subjacent to the Subathoo group. These on the main range of hills have been more developed than on the salt range; they have also been much more indurated, and very much more disturbed, but are supposed to be one and the same.

While, therefore, in deference to its fossils, the Subathoo group has

been classed as Upper Nummulitic, it must be remembered that, considered stratigraphically, it should be considered as the commencement of the Siwalik conditions of deposition.

The northern extension in the outer Himalayas of this Lower Nummulitic series, the Król group and the subjacent slaty schists, has not been as yet worked out. The section through Simla to Kotgurbh (forty miles N.E. of the Król) presents no contrasting junctions like those already described in the outermost zone; there are several lines of special crushing and contortion, but they do not introduce new rocks. The degree of disturbance is not on the whole increased, and the increase of metamorphism is very gradual and strangely capricious. Thus at Simla highly schistose rocks overlie smooth slaty grits. Indeed, it seems highly probable that the rocks of this section will be identified with, or found closely connected with, the Król series. Simla stands on the northern rise of a great synclinal bend, of which the Tara-Devi hill is the southern rise; at Jatog, the western spur of the Simla ridge, there are some hard cherty limestones that may well be the Król limestone; the thin-bedded slaty grits in the glen below Simla are very similar to the series subjacent to the Król group; among all these are frequent reappearances of the carbonaceous (graphitic) ingredient that is so well developed on the S.W. base of the Król hill.

Besides their greater induration, these Lower Nummulitic rocks differ from the Subathoo group in the presence of trap rocks. Towards the east these are very abundant; west of the Jumna, trap rocks are scarce.

Siwaliks.—Little has been added to our knowledge of these rocks since Captain (now Colonel Sir Proby) Cautley described them in 1836. (Trans. Geol. Soc. London, vol. v. p. 267.) Indeed, even the suggestions thrown out by him have not been followed up further. He pointed out that the connection between the subordinate range and the higher hills could be traced in the Nahun district, where the two were continuous without any intervening dún, yet none of the many subsequent fossil-seekers seem to have adopted the hint.

Captain Cautley roughly divided the whole series into three groups without defining the extent of each: 1st, the lowest, coarse clays containing reptilian and mammalian remains; 2d, blue marl with freshwater shells; and 3d, sandstones and conglomerates, which were the chief source of the larger mammalian remains. The true value, or even the correctness of these sub-divisions Mr. Medlicott was not prepared to establish, but several facts point to a much wider difference between the groups than Cautley supposed. Considerable faulting exists, and the rocks brought into junction by these faults suggest some new facts. In the valley north of Nahun, thick soft grey lignite sandstones, with subordinate beds of lumpy gritty red clay, are, by the great fault already noticed, brought into contact with a crushed rock of the Subathoo Nummulitic strata, and of the infra-Król shales. South of Nahun, where the Markunda extricates itself from the higher hills, the lower beds of the same series, in which clay predominates, are in junction, along a fault, with thick shingle beds of the outer Siwaliks, the topmost beds of the whole series, and in which the lower hills commence. The Nahun rock is continuous along the hills bounding the north side of the dún both to east and west. It is the lignite sandstone, the same as that noticed by Captain Strachey as occurring below Nainee Tal (from this the Dechouree iron-works now derive their ore), and it is also the Siwalik-like sandstone noted by Major Vicary, north of the Pinjore Dún. Captain Cautley always considered these Nahun rocks as belonging to the Siwalik formation, but it does not appear that he identified them with the sandstones north of the dún.

The continuity of this fault renders it probable that its throw is very

considerable. To attain anything like an exact estimate of this, the position of the Nahun beds in the general series must be ascertained. This is by no means an easy question. And though not prepared to settle the point definitely, it may be useful to show how the matter stands.

Captain Cauley referred the Nahun rocks to the *lowest* member of his threefold division of the Siwaliks. Now, large mammalian remains are found in the earthy sand and boulder-beds immediately to the south of the fault—thus the top and the bottom beds of the entire series, so far as we know them, are here brought into contact. But, further, the boulders in this outer rock, at the junction, are boulders of the lignite sandstone of Nahun hill; there is no other rock in section to the north that could have yielded them. And this fact would seem to involve either a want of strict correspondence between the Nahun hill beds, and any others in the section to the south of them, or else a total break of conformable sequence in that section. A much more careful examination of fossils and of the strata, than a preliminary survey would warrant, will be required to decide this.

This raises a question as to the successive deposition and upheaval of great banks of these Siwalik strata, which again recurs in the west. It has long been noticed, that there was a great expansion of the Siwalik area in the west, commencing just beyond Kalka and Kassowli. It is occasioned by a curve in the great boundary fault, which here alters its direction to about 15° W. of N.; while the outer line of the Siwalik hills preserves nearly its former direction. In Mr. Greenough's map the sharpness of change in the boundary about Belaspur is exaggerated both by inaccuracies in position of localities and because he includes the Subathoo, or Upper Nummulitic group, the inner or northern boundary of which is much more irregular than the main fault which separates this group from the Siwalik series.

Now, the Siwalik rocks occupy this increased area, not by the extension of the strata already noticed, but by the successive introduction, by faults, of other bands of rock not strictly identifiable with the outer Siwaliks. Even at the Sutlej there are two such bands between the Nahun ridge and the main fault, as seen near Belaspur.

It is not intended to state that our knowledge of the existence and distribution of fossils in these rocks is conclusive; but, so far as known, with the single exception of the discovery by Lieutenant (now Colonel) Durand of fossils near Nahun, there is *no known instance of fossils being found out of the first zone of these rocks—the Siwaliks proper.*

If we attempt to base our inferences upon lithological grounds from the composition and texture of the strata, in a continuous section like this, we must include the Upper Nummulitic group, for, as already stated, it has, in these respects, very marked affinities with the Siwalik series. Many of the lumpy red clays of the Dugshai group are not distinguishable in composition or in hardness from the clays of the Upper Siwaliks; the sandstones also of the same group are markedly of the same general type. Each of these bands, then, has affinities with the one on either side of it, and at the same time has irreconcilable contrasts also. The Belaspur conglomerates overlie, with, at least, general conformity, thick red clays and hard sandstones, exactly like the Dugshai group, yet without any intervening beds to represent the Kusowli group; and these conglomerates undoubtedly contain debris of the Nummulitic series. The rocks south of the Gumber fault are very similar to the Belaspur band, and the bottom strata are of an intermediate type between the Dugshai and the Lower Siwalik strata, being in fact with difficulty distinguishable from the rocks of the Nahun range, with which they are in contact. And lastly, we have the Nahun rocks which are lithologically undistinguishable from the lower

strata of the Siwalik hills, while the upper strata of these same hills contain boulders of these Nahun rocks.

All these facts seem compatible only with a long continued, and generally contemporaneous process of upheaval, denudation, and deposition, under conditions commencing with the Upper Nummulitic rocks. This conclusion is entirely at variance with the premature generalisation at which Mr D'Archiac arrived.

In conclusion, the importance of carefully labelling fossils and distinguishing their localities cannot be too strongly insisted on.—*Henry R. Medlicott in Journal of the Asiatic Society of Bengal.*

Ichthyosaurus Normanniae.—This is a new fossil reptile, which has been found by M. A. Valenciennes, in the Kimmeridge clay of Bleville, to the north of Cape le Heve, near Havre. It differs from the *Ichthyosaurus Platyodon* of Lyme Regis, markedly in the form of the basilar process of the occipital bone.—*Comptes Rendus, Dec. 2, 1861.*

BOTANY.

Umbelliferae of Australia and Tasmania. By Dr FERDINAND MUELLER.—Of the numerous paradoxical plants which characterise the Flora of Australia to such a great extent, those of the Umbelliferae are not the least interesting; and I beg to review briefly on this occasion the various members of this order, which, through the exertions of many a naturalist, became successively known from Australia and Van Diemen's Land.

In Labillardière's "*Novæ Hollandiæ Plantarum Specimen*" (published in 1804), we meet with the first account of the curious genus *Actinotus*. He describes and figures also *Daucus brachiatus*, Sieber (under the name *Scandix glochidiata*), *Apium prostratum* (the native celery), *Eryngium vesiculosum*, and three species of *Trachymene* as *Azorellas*, to which genus, indeed, they are closely allied. In 1805 a second species of *Actinotus* from New South Wales was defined by Sir James Smith with the original one, under the name of *Eriocalia*, but it was reduced to the older genus of Labillardière by the illustrious Robert Brown, in his Appendix to Captain Flinders' Voyage (1814). To Rudge we owe in a paper issued by the Linnean Society of London (1811), the proper definitions of the genera *Trachymene* and *Xanthosia*, and Sprengel, Sieber, and De Candolle added to the former genus, Cavanilles having previously referred one species to *Azorella*. Achille Richard added (in 1820) to our knowledge of these plants various species of *Hydrocotyle*, principally supplied by Robert Brown; and Allan Cunningham characterised in Field's Geographical Memoirs of New South Wales (1825) his *Eryngium ovinum*. The invaluable "Prodromus" of De Candolle brings in the fourth volume (published in 1830) important additions; the genera *Dimetopia* and *Astrotricha* are here for the first time distinguished, and new species are added to *Hydrocotyle*, *Trachymene*, *Xanthosia*, and *Eryngium*; and *Helosciadium leptophyllum* is shown to be an Australian plant; Sir William Hooker having previously given in the "Botanical Magazine" (t. 2875) publicity to two species of De Candolle's genus *Didiscus*. From the collections of Bauer, Cunningham, and Baron Huegel, new contributions were made to the Australian Umbelliferae by the labours of Bentham, incorporated in the "*Enumeratio Plantarum Novæ Hollandiæ Austro-occidentalis*" of Huegel (1837), by which the genera *Hydrocotyle*, *Didiscus*, *Trachymene*, *Leucolæna* or *Xanthosia*, *Astrotricha* and *Actinotus* became augmented. The Australian species of *Caldasia* (*Caldasia eriopoda* of De Candolle's "Prodromus"), a plant which exhibits the most extraordinary varieties, changed its preoccupied generic name into *Oreomyrrhis* in Endlicher's celebrated "*Genera Plantarum*" (1840); *Pentapeltis*, pre-

viously (1857) published as *Leucolena* by Hooker, and afterwards elevated by Bunge to generic rank, forms here a sub-genus; whilst *Cesatia*, a genus seemingly near to *Didiscus*, received its characteristics by the same author in the Annals of the Vienna Museum. In the important work, edited 1845 by Lehmann, on the Plants of Preiss from Western Australia, a work so replete with novelties, Bunge made us acquainted not only with new *Hydrocotyles*, *Trachymenes*, and *Xanthosias*, and with two *Eryngiums*, perhaps also new, but he discriminates also the genera *Schanolena* and *Platysace*, and unites *Pritzelia* of Walper to *Dimetopia*. Mr Ronald Gunn's and Dr Milligan's zealous investigations of the Tasmanian Flora enabled Dr Joseph Hooker to elucidate with his usual skill the new genera *Hemiphues*, *Diplaspis*, and *Microsciadium* in the sixth volume of the "London Journal of Botany" (1847), together with new Tasmanian *Hydrocotyles*; the same famous botanist having introduced *Didiscus humilis* and *Xanthosia dissecta* into the "*Icones Plantarum*" a while before; and in his admirable Flora of New Zealand he identifies the Australian *Orantzia* with an American species.

In the year 1847 we find proved in Schlechtendal's "*Linnaea*" the existence of the European *Sium angustifolium* in Australia, from specimens sent by Dr Behr; and we observe nearly simultaneously an account of a new *Dimetopia* by Bunge in Schlechtendal's and Mohl's "*Botanische Zeitung*;" two other species of that genus are noted by the same acute botanist the year before in an index of plants cultivated in the Botanic Garden of Dorpat. The next contributions are chiefly from the West Australian collections, prepared by the venerable Drummond, which offered to Turczaninow the opportunity of enriching the system of umbelliferous plants with additional species of *Hydrocotyle*, *Didiscus* (referred by him to *Dimetopia*), *Trachymene*, *Xanthosia*, and *Platysace*, the diagnostics of which appeared in the twenty-second volume of the "*Bulletin de la Société Impériale des Sciences Naturelles de Moscou*," and are reprinted by Walpers in his useful "*Annal. Botan. System.*" a periodical which we regret seeing discontinued after the death of its laborious and ill-supported author,* and which was formerly the principal source of information to botanists abroad, and to travellers who had no direct access to numerous botanical works for which the "*Repertorium*" and the "*Annales*" of Walpers formed a valuable substitute. In the first volume of the latter (issued 1849), we observe the genus *Microsciadium* inserted as *Oschatzia*, since the Hookerian appellation was pre-employed by Boissiet for the distinction of a new oriental umbellate.

During the botanical exploration of the colonies of South Australia and Victoria (from 1847 till 1855), it fell to the share of the author of this memoir to disclose new forms of *Hydrocotyle*, *Didiscus*, and *Dimetopia*, to point out the range of the Tasmanian genera *Dichopetalum*, *Oschatzia*, and *Diplaspis*, as far as the alps of the Australian continent; and also the occurrence here of *Pozoa*, *Seseli* and *Aciphylla*, the latter combinable with *Gingidium*, both established simultaneously in Forster's "*Characteres Generum Plantarum*" as early as 1775. Definitions of the last mentioned species are partly given in the twenty-fifth volume of the "*Linnaea*," and partly in the "Transactions of the Philosophical Society of Victoria," and in those of the Victorian Institute. Dr Joseph Hooker refers the genus *Pozoopsis* of the "*Icones Plantarum*," as a second species, to *Diplaspis*, in his "Flora of Tasmania," and states the approximate number of Australian *Umbelliferae* as 120, from which remark it appears that several plants of

* This work has been continued by Dr Charles Mueller of Berlin.—[EDIT. Phil. Jour.]

this order continued undescribed, although existing in herbaria; and, indeed, several unknown to botanists are mentioned in the works of travellers. Thus, Allan Cunningham speaks of a north-west Australian *Azorella* in the appendix to King's "Intertropical Survey of Australia," as being remarkable for its gigantic herbaceous growth."

The last expedition through the intra-tropical zone of this country, so ably conducted by Mr Augustus Gregory, has but furnished a limited number of plants belonging to *Umbellatæ*; yet, perhaps, even more than might have been expected from the known geographical distribution of this order. As new, I may mention a *Hydrocotyle*, two *Eryngia*, four *Didisci*, and a genus which may be distinguished (as *Platycarpidium*) from *Astrotricha* in deciduous petals, from *Trachymene* in flat and smooth carpels, from *Platysace*, as far as the immature state of the fruit permits me to judge, by the want of vitte, and from *Didiscus* and most of the allied genera by a tall, shrubby habit, so unusual in this order, and, finally, in a paniculate disposition of its umbels, of which the greater number, notwithstanding their being hermaphroditical, remain perfectly sterile.—*Proceedings of the Royal Society of Tasmania*, vol. iii. part 2.

Formation of Wood.—M. Hétet has continued his researches in regard to the formation of woody tissue. With this view he has examined the development of the wood in *Yucca aloefolia*, *Y. superba*, *Dracena fragrans*, *D. ferrea*, a species of *Cordyline*, *Aloe aborescens*, *A. pseudo-ferox*, among the monocotyledons; and in *Nerium*, *Ficus*, and more especially *Pircunia* (*Phytolacca*, L.) among the Dicotyledons. From his experiments he draws the following conclusions: 1. In Dicotyledonous trees of rapid growth, and with much parenchymatous tissue, the most deeply situated cellular zones, and even the medullary canal, can reproduce ligneous bundles and a cortical tissue. 2. Fibrous and vascular bundles are formed wherever there are young and active cells. 3. The experiments lead to conclusions opposed to the views of Petit Thouars and Gaudichaud, that the increase of stems in Dicotyledons takes place by means of descending fibres.—*Comptes Rendus*, Dec. 2, 1851.

"*Calluna vulgaris*" and "*Aira caryophyllea*" in the United States.—That America has no heaths is a botanical aphorism. It is understood, however, that an English surveyor, nearly thirty years ago, found *Calluna vulgaris* in the interior of Newfoundland; also that De la Pylaie, still earlier, enumerates it as an inhabitant of that island. But this summer, Mr Jackson Dawson, a young gardener, has brought us specimens and living plants (both flowering stocks and young seedlings) from Tewksbury, Massachusetts, where the plant occurs rather abundantly over about half an acre of rather boggy ground, along with *Andromeda calyculata*, *Azalea viscosa*, *Kalmia angustifolia*, *Gratiola aurea*, &c., apparently as much at home as any of these. The station is about half a mile from the State Almshouse. Certainly this is as unlikely a plant, and as unlikely a place for it to have been introduced by man, either designedly or accidentally, as can well be imagined. From the age of the plants it must have been there for at least a dozen years; indeed, it had been noticed and recognised two years ago by a Scotch farmer of the vicinity, well pleased to place his foot once more upon his native heather. So that even in New England he may say, if he will, as a friend of ours botanically renders the lines—that

Calluna vulgaris this night shall be my bed,
And *Pteris aquilina* the curtain round my head.

It may have been introduced, unlikely as it seems, or we may have to rank this heath with *Scolopendrium vulgare*, *Subularia aquatica*, and *Marsilea quadrifolia*, as species of the Old World, so sparingly represented in the

New, that they are known only at single stations, perhaps late-lingers rather than new-comers.

Aira caryophyllea has just been detected by W. M. Canby, Esq., in Newcastle County, Delaware, growing very abundantly on a dry piece of ground, rather open, but dotted over with pine trees (*Pinus inops*), and completely surrounded by a forest. It certainly has not been ploughed for ten years, probably not for a much longer time. In company with it was *Polygala Nuttallii*, *Sorghum nutans*, &c., but no clover, *Timothy*, or any of the grasses usually cultivated. Still we suppose this species to have been introduced.—Professor Asa Gray in "*Silliman's Journal*," Sept. 1861.

CHEMISTRY.

Venom of the Rattlesnake (Crotalus).—Dr Mitchell states that the venom of *crotalus* is an acid fluid, abounding in albuminous matter, and yielding precipitates or coagula with certain reagents. The active element seems to exist in the albuminous compound. Alcohol precipitates all the albuminoid material, innocent as well as poisonous; and heat throws down from diluted venom the bulk of those albuminous compounds in an insoluble and harmless form; the residual water still containing an albuminous acid body (*crotaline*) uncoagulable by heat, but precipitable by alcohol, and of great poisonous activity. The venom of the rattlesnake has been found to be composed of—

1. An albuminoid body, *Crotaline*, not coagulable by heat of 212°.
2. An albuminoid compound coagulable by a temperature of 212° F.
3. A colouring matter, and an undetermined substance, both soluble in alcohol.
4. A trace of fatty matter.
5. Salts, chlorides, and phosphates.

Habits of the Rattlesnake (Crotalus) when in Captivity.—During a large part of two years, the period which this research has occupied, I was a portion of each day in the room where the reptiles were kept, and consequently observed with care such of their habits as could be studied while they were in confinement. In regard to these I have a few observations to make, before considering their physiology and toxicology.

It is by no means my intention to give a full account of the habits of the *Crotalus*, since this would involve a great deal of detail which is to be found elsewhere, and which would be foreign to the general purpose of this essay.

The rattlesnake of our Northern States, when at liberty, sometimes lives in the company of his fellows, but more frequently alone. I have had, in a single box, from ten to thirty-five snakes, and have never observed the slightest signs of hostility towards one another. Even when several snakes were suddenly dropped upon their fellows, no attempt was made to annoy the new-comers, while the sudden intrusion of a pigeon or a rabbit was met with ready resentment, whenever the snakes were fresh and in vigorous health.

The habits of rattlesnakes, when in confinement, are singularly inactive. Even in warm weather, when they are least sluggish, they will lie for days together in a knotted mass, occasionally changing their position, and then relapsing into perfect rest. The contrast between this ordinary state of repose, or sluggish movement, and the perilous rapidity of their motion when striking, is most dangerously deceptive. In contrast also with their slow locomotion is the marvellously rapid action of their rattles, which, when annoyed or molested, they will sometimes continue to agitate for hours at a time.

It is the general experience of those who have kept rattlesnakes, that

they seldom eat in captivity. I have known a snake to exist for a year without food; and although I have made every effort to tempt my own snakes, I have never seen any one of them disposed to avail itself of food, when placed within its reach. Dumeril states that this is the usual experience in the Garden of Plants, but that at the end of six or eight months they commonly accept food. He also adds that the very young pigeon is the food they are most inclined to eat.

After tempting the snakes with this, as well as with birds, mice, rabbits, &c., and finding the food as often untouched, I finally gave up the attempt, and contented myself with feeding, by force, such of them as seemed feeble and badly nourished. For this purpose, I used milk and insects, which I placed in their throats, while they were properly pinioned. To effect this, the snake was secured, and the lower jaw held in the grasp of a pair of forceps, while a funnel, with a long stem, was thrust down the oesophagus. Into this, insects, such as flies and grasshoppers, were pushed, or milk poured in proper quantity. Yet, even when this precaution of forcible feeding was not employed, the snakes remained healthy, and secreted, as usual, a sufficient amount of venom.

To preserve them, however, in good condition, it is absolutely necessary that they should be frequently supplied with water, especially in hot weather, and when they are about to shed their skins. The free snake is said, in this climate, to shed its cuticle in the month of August. My snakes lost their old integuments at different periods, during the summer. In all cases, the old skin became very dark, as the new one formed beneath it. If, at this time, the snakes were denied access to water, the skin came off in patches. Where water was freely supplied, they entered it eagerly at this period, and not only drank of it, but lay in it for hours together. Under these circumstances, the skin was shed entire—the first gap occurring at the mouth, or near it. Through this opening, the serpent worked its way, and the skin reverting, was turned inside out, as it crawled forth in its new and distinctly-marked outer covering. When the old skin was very loose, this snake's motions were often awkward for a time. It is said to be blind during this period, which is probably true to some extent; since the outer layer of the cornea is shed with the skin, and there must obviously be a time when the old corneal layer lies upon the new formation. It is also said that the fangs are lost at the same time as the skin. In some instances, this was observed to be the case; but whether or not it is a constant occurrence, I am unable to say from personal observation.

It is most probable, as I have elsewhere stated, that not only are the fangs shed when the skin is lost, in summer, but that their loss is a frequent occurrence, like the loss of teeth in certain fish, and takes place at intervals more or less frequent, certainly oftener than once a-year.

A general opinion prevails that, immediately after the loss of the skin, the snakes become most virulent. As they are slothful during the period of change, and strike then with reluctance, if at all, and as the loss of the fang involves, to some extent, the accumulation of poison in the gland cavities, this view may be correct. There is no ground, however, for supposing that the effect of this storing up of the venom would be greater at this period than after a similar amount of accumulation at another time.

After such numerous and long-continued opportunities of observation, it might be supposed that I should be prepared to speak authoritatively, as to the still disputed power of the snake to fascinate small animals. If the power exist at all, it is probable that it would only be made use of when the serpent required its aid to secure food. We have seen that even the most healthy snakes lose their appetite when imprisoned, and beyond this

condition, my chances of observation have been limited. Those who are still curious in the matter will find the fullest account of it in the Essay of Dr B. S. Barton. In despite of the learned and ingenious argument of this author, there are not wanting large numbers, who claim to have witnessed, again and again, the exercise of the power of charming on the part of the rattlesnake and black snake. Dr Barton, who does not deny that the appearance of fascination has been often observed, explains it by supposing that in these cases the parent bird, alarmed at the near approach of danger to her nest of young, hovers anxiously about the snake, as she would about any other cause of danger, and thus sometimes falls a victim to her maternal anxiety. This theory, Dr Barton believes sufficient to account for the fluttering and strange movements of the bird; and the arguments with which this view is upheld are certainly entitled to great respect. While the anxiety and terror of the parent bird would readily attract notice, the real object of the snake, and the true cause of the mother's approach to the very jaws of destruction, would be more than likely to escape the notice of such persons as are usually called upon to observe the supposed fact.

I have seen but one occurrence that might mislead as to the subject of fascination. I have very often put animals, such as birds, pigeons, guinea-pigs, mice, and dogs, into the cage with a rattlesnake. They commonly exhibited no terror after their recovery from alarm, at being handled and dropped into a box. The smaller birds were usually some time in becoming composed, and fluttered about in the large cage until they were fatigued, when they soon became amusingly familiar with the snakes, and were seldom molested, even when caged with six or eight large *Crotali*. The mice—which were similarly situated—lived on terms of easy intimacy with the snakes, sitting on their heads, moving round on their gliding coils, undisturbed, and unconscious of danger. Larger animals were not so safe, especially if they moved abruptly and rapidly about the snakes. The birds, mice, and larger animals, often manifested an evident curiosity, which prompted them to approach the snake cautiously. Sometimes this was rewarded by a blow, as was sure to be the case when a dog indulged his inquisitiveness by smelling the snake with his muzzle. Sometimes the snake retreated, and struck only when driven to bay. Usually, the smaller animals indulged their inquisitive instinct unhurt, and were allowed to live for days in the same cage with the dreaded reptiles.*

These are the sole facts which I have seen, bearing any relation to the supposed fascinating faculty. They appear to me to lend no strength to the idea of its existence.

There is a popular belief which ascribes to the rattlesnake a most disagreeable odour, and even naturalists have been led to believe that the serpent owed to this its power to lure and stupefy animals. In this matter I agree with Barton.† I have never perceived that any peculiar odour issued from my snake-box; and as to its ability to injure birds, the facts above stated should suffice to disprove it. As usual, however, this pound of error contains its grain of truth. When a rattlesnake is roughly handled, especially about the lower half of its length, a very heavy and decided animal odour is left upon the hands of the observer. If the snake be violently treated, causing it to throw itself into abrupt contortions, thin streams of a yellow or dark brown fluid are ejected to

* It is proper to add, that the curiosity thus exhibited by animals, and especially by mice and dogs, was as active when the snake was not regarding the intruder as at other times.

† Barton, p. 24.

the distance of two or three feet. This fluid appears to come from glands alongside of the cloaca. Its odour is extremely disagreeable, and it is irritant when it enters the eye, although not otherwise injurious.—*Researches upon the Venom of the Rattlesnake*, by S. Weir Mitchell, M.D. 1861.

MISCELLANEOUS.

The Influence of an Acid in producing Saccharine Urine. By F. W. PAVY, M.D.—In 1854 I conducted an experiment to determine the effect of depriving the blood of its natural alkalinity. I then wished to see if I could influence the presumed destruction of sugar in the blood during its transit through the lungs. Phosphoric acid (Pharmacopœia strength), to the extent of $7\frac{1}{2}$ fluid drachms, was injected into the jugular vein of a dog, and the blood of the arterial system became strongly charged with sugar. Since this experiment was performed, it has been ascertained that there is not the difference during life in the blood on the two sides of the lungs that was formerly supposed to exist; and it has become evident that it was not to arresting any change in the lungs, as I at first supposed, that the result I obtained was due. The fact of the blood being rendered saccharine, led me to infer that a saccharine state of the urine might also be occasioned. In seven instances I have tried the effect of injecting phosphoric acid into the general circulation. I find that it is an experiment which requires to be performed with the greatest nicety: the animal withstands the introduction of the acid to a certain extent without manifesting any disturbance, and it may even, at first, be injected pretty rapidly; but when a certain amount, varying in different instances according to the size of the animal, has been introduced, the further introduction requires to be made most slowly and with the utmost care, attentively watching its effects; otherwise destruction of life will be occasioned. I have found this to occur in one case after one ounce had been employed, and in another after ten drachms: in both of these cases the animals were of a smallish size. In two good-sized animals the injection of an ounce did not thus lead to immediate death, and did not produce any alteration in the state of the urine as far as regards sugar. Having carried the experiments further, however, I find that when the injection is pushed to the fullest extent that the animal will safely bear, a saccharine state of the urine is the result.—*Proceedings of the Royal Society.*

Experiments and Observations on the Structure and Function of the Stomach in the Vertebrate Class. By WILLIAM BRINTON, M.D., Lecturer on Physiology at St Thomas's Hospital.—This paper, itself a summary of a long series of observations, may be briefly abstracted as follows:—

The peculiar dimorphous structure possessed by the tubes of the cardiac and middle parts of the stomach in the dog, exists in the whole vertebrate class; about sixty species of which are cited by the author from his notes. Many of the variations of the stomach throughout the vertebrate class are essentially œsophageal developments, having a mechanical office. The more essential contrasts of the vertebrate stomach refer to the above dimorphous structure; which diminishing, even in man, to less than twice its thickness in passing from the cardia to the pylorus, is in most animals altogether deficient here, either with or without a great shortening of the columnar-celled tubes. The dimorphous cell-growth is always the source and exponent of the pepsinous or digestive power of the stomach on protein-compounds; which power is absent where this structure is deficient, and present (as tested by careful comparison) in the

degree in which the mucous membrane contains the dimorphous cell-growth. Of those alternatives respecting the gastric juice suggested by various experiments,—namely, (1) the secretion of pepsine by the dimorphous cell-growth, and acid by the columnar; or (2) the perfecting of the secretion (itself perhaps owing these two constituents to its two kinds of cell respectively) in the open ends only of these tubes,—the latter is, on the whole, preferable. The protection of the stomach from its own secretion is effected mainly by the salivary and other secretions which enter it from the œsophagus and duodenum. The living stomach decomposes a neutral or alkaline blood, so as to set free an acid; but though transfused blood undergoes this decomposition, a saline solution not only fails to evoke it, but injures or destroys the gastric powers. There is no evidence of any exhaustion of the pepsinous constituents of the gastric mucous membrane at any period of digestion. As regards other variations of power, *age* seems to exercise but a moderate influence on the gastric mucous membrane; *species*, again, has a subordinate effect; *genus* is much more influential. For units of mucous membrane, fishes seem to have the most powerful gastric digestion. The influences of temperature, analogous in all animals, vary exceedingly as regards the absolute heats which respectively favour, accelerate, and destroy the powers of the stomach; so that the same heat which is practically necessary for the function of this organ in a warm-blooded mammal, annihilates the efficacy of the pepsine of many fishes. The action of the gastric juice is a transfer to albumen, &c., of a molecular change going on in the gastric juice—pepsine and peptone being essentially analogous to each other in properties. The formation of peptone is a hydration of albumen, as shown by various collateral circumstances of the process.

Addenda.—1. The pancreatic juice, or pancreatic infusion, which converts albumen into a substance akin to peptone, and in proportions not very unlike those which would be obtainable by using certain parts of the mucous membrane of the stomach of some animals, and which does this by a process so far *sui generis* as that it is no way shared by the salivary organs most analogous to itself in structure and function, is yet distinguishable from the gastric juice in regard to the process and the product of this change. The change is, indeed, an incident of putrefaction only, and therefore not a function of the healthy living organ. 2. The intestinal juice, or the secretion of the intestinal tubes, is neither capable of converting albumen, &c., into peptone, nor of converting starch into sugar. The offices of these tubes are therefore, probably, chiefly of absorption and of excretion.—*Proceedings of the Royal Society.*

PUBLICATIONS RECEIVED.

Quarterly Journal of the Chemical Society for October 1861.—*From the Society.*

Manual of the Sub-kingdom Cœlenterata. By Professor JOSEPH R. GREENE.—*From the Author.*

Journal of the Asiatic Society of Bengal, No. II., for 1861.—*From the Secretaries.*

Practical Treatise on the Use of the Ophthalmoscope. By J. W. HULKE, F.R.C.S.—*From the Publisher.*

Proceedings of the Literary and Philosophical Society of Manchester, Nos. III. to VI., Session 1861-62.—*From the Society.*

Proceedings of the Academy of Natural Sciences of Philadelphia, 1861. Pp. 65 to 144.—*From the Society.*

Scripture and Science not at Variance. By Archdeacon PRATT.—*From the Publisher.*

Dublin Quarterly Journal of Science, No. IV., October 1861.—*From the Editor.*

Metallurgy. By JOHN PERCY, M.D.—*From the Publisher.*

Annales de l'Agriculture des Colonies (Algerie) et des Regions Tropicales. Par N. PAUL MADINIER. Nos. VII and VIII., for 1861.—*From the Author.*

Astronomical Observations in the Arctic Seas. By Dr E. K. KANE.—*From the Smithsonian Institution.*

Meteorological Observations made near Washington, Arkansas. By NATHAN D. SMITH, M.D.—*From the Smithsonian Institution.*

Meteorological Observations made in Providence, R.I. By Professor ALEXIS CASWELL.—*From the Smithsonian Institution.*

Tidal Observations in the Arctic Seas. By Dr E. K. KANE.—*From the Smithsonian Institution.*

Report on the Chemical Analysis of the White Sulphur Water of the Artesian Well of Lafayette, Ind. By Dr CHARLES M. WETHERELL.—*From the Author.*

General Outline of the Organisation of the Animal Kingdom, and Manual of Comparative Anatomy. By THOMAS RYMER JONES, F.R.S. Third Edition.—*From the Publisher.*

Researches upon the Venom of the Rattlesnake, with an Investigation of the Anatomy and Physiology of the Organs concerned. By S. WEIR MITCHELL, M.D., Lecturer on Physiology in the Philadelphia Medical Association.—*From the Author.*

Second Report of a Geological Reconnoissance of the Southern and Middle Counties of Arkansas, made during the years 1859 and 1860.—*From D. D. Owen, Principal Geologist.*

THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

On the Climate of Palestine in Modern compared to Ancient Times. By JAMES D. FORBES, D.C.L., LL.D., V.P.R.S.E., Principal of the United College of St Salvator and St Leonard, St Andrews.*

Since thermometric observations extend back for only about two hundred years, and even these are very limited, and often of questionable precision, we are compelled to rely, in any comparison between ancient and modern climates, upon authentic records of phenomena depending upon heat and cold, which are also capable of being definitely described.

Such are instances of the freezing during winter of considerable rivers and other bodies of water, the periods of harvest of different crops, and generally the limitation of the growth of certain species of plants by conditions of climate.

The first of these tests, though not unworthy of notice, is not only somewhat vague, but depends upon the recurrence of seasons of extraordinary and not ordinary severity, which we know to be amongst the most uncertain and capricious of meteorological data.

The significance of the two last tests—the date of harvest, and the growth of certain critical plants in certain localities—was ably pointed out by the eminent Danish botanist Schouw of Copenhagen. These tests form the chief arguments of his able paper on supposed changes of climate. I am only acquainted with the first portion of this paper, as published in the

* Read before the Royal Society of Edinburgh, 6th January 1862.
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"Edinburgh Journal of Science" for 1828.* Whether the original has ever been published in full in the Danish Transactions or elsewhere, I am unable to state.

The most striking part of this interesting fragment refers to the climate of Ancient compared to that of Modern Palestine, for the discussion of which we possess data at once more extensive and applicable to a more remote epoch than can be jointly furnished by the records of any other country. Having recently had occasion to redirect my attention to Schouw's argument, and having had leisure to verify it by a reference to the researches of the last thirty years, I have thought it well to record the conclusions to which I have come, on a subject of some popular as well as scientific interest.

Passing over for the present the argument in favour of the conclusion that the climate of Palestine has not sensibly changed since the days of Moses, derived from the fact that the wheat harvest and vintage still occur at the periods of the year fixed with sufficient definiteness in the Old Testament, we will take up Schouw's striking and ingenious argument derived from the simultaneous cultivation in Judea of the vine and the date-bearing palm.

The argument is briefly as follows:—The date-palm (*Phoenix dactylifera*) was in ancient times abundant in many parts of Palestine, where its fruit ripened. This we learn from both sacred and profane authors, and also from Roman coins. On the other hand the vine (*Vitis vinifera*) was notoriously an abundant product of the same country, where it attained extraordinary perfection, and was in habitual and extensive use for the manufacture of wine. Now, the botanical inquiries of Schouw led him to conclude, that the date tree requires for perfect fertility a mean temperature of the year not under 21° Centigrade, or 69°·8 of Fahrenheit. The mean temperature therefore of those parts of Palestine where the date was historically abundant, could not anciently have fallen below 70° (in round numbers). But the vine does not endure a tropical climate. According to Von Buch, quoted by Schouw, it ceases to flourish productively in the Canary Isles,

* Vol. viii. p. 311.

Algiers, and Egypt, wherever the mean temperature of the year approaches 22° Centigrade, or 71°·6 Fahrenheit. The co-existence of these two plants in a fruitful condition shuts us up to the conclusion, according to this author, that the mean temperature must have anciently been intermediate between 70° and 72°. In the absence of direct observations of the temperature of Jerusalem, he infers, from the ascertained modern temperature of Cairo and other places, that Jerusalem has probably 70° of mean temperature. "If, therefore," he adds, "there has been any difference at all between the mean temperature of Jerusalem in ancient and modern times, it can hardly amount to one degree (Centigrade), a difference similar to that between Copenhagen and Berlin."*

It might have been expected that Arago, when availing himself much more recently of the arguments of Schouw on this subject, would have thrown the farther light upon them which the improvement of meteorology and botanical geography, as well as the local researches of modern travellers, might have afforded. He has, however, contented himself with translating, almost literally, the memoir of the Danish botanist.†

On reconsidering carefully the evidence for the permanence of the climate of Palestine, as given by Schouw, it appeared to me that it was open to doubt on the following grounds:—(1.) That no consideration is given to the well-known facts, that Jerusalem is placed at a great elevation (2200 feet) above the level of the Mediterranean, and that Palestine is altogether a mountainous country, and therefore includes a considerable variety of climates respectively suited to different classes of plants. The importance of this consideration is such as to invalidate the otherwise ingenious reasoning of the Danish botanist. (2.) That Schouw confined his attention to mean

* *Edinburgh Journal of Science*, viii. 316. In confirmation of his argument Schouw adds, "The frequent cultivation of wheat in Palestine proves that its temperature cannot have been above 24° or 25° (Cent.) The growth of the balsam tree, near Jericho, proves that it has not been below 21° or 22°; and among all other determinable plants and animals of Ancient Palestine, the author could not find a single one which was contrary to the assumed mean temperature of 21°."

† Arago, "*Œuvres*," viii. p. 215. Compare "*Annuaire, &c., pour 1834*," p. 204.

annual temperature alone as a cause of limitation of species, whereas it is now well known that the distribution of heat at different seasons of the year forms an important element in determining the limits of many plants.

To these considerations, we may add the fresh evidence on the subject arising from our being now in possession of larger data, (3.) as to the meteorological character of Syria, and of Judæa in particular; (4.) as to the general facts and laws of the distribution of plants, and especially of the vine and palm; and, (5.) what has been somewhat unaccountably overlooked by Schouw and Arago, as to the actual occurrence of those plants in Modern Palestine.

I shall in the following pages endeavour to sum up the whole argument (which proves to be confirmatory of the opinion of Schouw as to the invariability of the climate), as it may be gathered both from older and more modern authorities.

In the interesting and laborious work of M. A. Decandolle entitled "*Geographie Botanique raisonnée*" (1855), we find such ample and conscientiously stated details, as to supersede a reference to any other botanical work in connection with the present inquiry. We there find it clearly laid down, that the Polar limit of the date-palm may be held to have a threefold margin—*1st*, Where the fruit comes to full maturity, as at Tunis, with a mean annual temperature of $68^{\circ}5$; *2dly*, Where it flowers but only ripens its fruit exceptionally, as at Algiers and Palermo, whose temperatures are nearly alike, and may be stated at $63^{\circ}7$ as a mean; and, *3dly*, Where it is cultivated exceptionally, as a merely ornamental tree, as at Nice and Rome, the temperature of both places being about 60° .

Now the climate of Southern Palestine, whether (a) as inferred from the Bible and other ancient testimonies, or (b) from meteorological observations, as collected by Dove, or (c) from the descriptions of modern travellers, seems to be definitely conformable to the view that its more mountainous parts correspond to the *second* limit of the date tree, and the valleys and coasts to the *first*—a hypothesis or assumption which reconciles all facts, so far as the palm is concerned.

Shaw, in his *Travels* (quoted by Kitto in his "*Physical Geography of the Holy Land*," p. ccxxv.), mentions numerous

coins belonging to the Roman occupation of Judæa, in which the palm tree is represented; in some of these it is figured with the fruit upon it (Schouw). It is more than probable that the association of this tree with Palestine, which caused the Romans to regard it as peculiarly characteristic, was derived from their first impressions of the country on the coasts of Philistia, near Jaffa, where the palm tree ripens its fruit copiously, as Professor Mitchell informs me; "and which there," as Professor Stanley remarks (*Sinai and Palestine*, p. 145), "probably first met the eye of the western world, whether Greek, Roman, or mediæval," giving rise to "the name of Phœnicia, or the Land of Palms."

I may here remark that the climate of the Syrian coast, in the latitude of Jerusalem, corresponds with that most favourable to the perfect development of the date tree. Beyrout, which is nearly 2° of latitude farther north than Jerusalem, has a temperature of 69°·4 (Dove), or nearly a degree of Fahrenheit higher than that of Tunis, and is intermediate in temperature between Tunis and the Canary Islands, both being places where the date ripens perfectly.

Jaffa and Gaza being to the south of Beyrout, must therefore be considerably warmer; and the isothermal line of 70° (at the level of the sea) must pass, according to Dove's maps, close to the *geographical* place of Jerusalem, though, in consequence of the elevation of that city (2200 feet, *Stanley*), it has a temperature far lower; in fact only of 62°·6, according to a single year's observation by an American missionary, quoted by Dove. But when allowance is made for the effect of elevation at the rate of about 300 feet for 1° Fahrenheit, this single year's result gives a temperature of almost exactly 70° for the parallel of Jerusalem. It is very probably rather higher, as Schouw had, from still more incomplete data, estimated it. From all this we conclude, that while the climate of Palestine at the level of the sea is perfectly adapted for the cultivation of the date palm, Jerusalem itself corresponds in temperature closely to Palermo, and is therefore, as already shown, only warm enough to enable it to produce flowers, but not to ripen the fruit, unless in exceptional seasons.

This inference from general meteorological facts is entirely

confirmed by the testimony of modern travellers as to the conditions under which the palm, where it does occur, is found in Palestine. But it will be best to inquire, first, as to the exact localities mentioned in Scripture as characterised by the growth of the palm. This is evidently rendered necessary by the great variety of climate which Palestine presents, owing to its varied elevation. The effect is so considerable, that even if we confine ourselves to the narrow limits of Judæa Proper, it must be held to be equivalent to a range of temperature of about 13° of latitude, and that without including heights greater than that of Jerusalem itself.*

The place which, beyond all doubt, was most characterised by the presence of the date tree was Jericho, "the city of palm trees" (Deut. xxxiv. 3; 2 Chron. xxviii. 15) which, as Kitto acutely remarks, would hardly have been a distinctive name, had the palm been as frequent in Palestine as it is in Arabia and Egypt. Now Jericho, as is well known, lies not only in a valley, but, being in the valley of the Jordan, not far from the Dead Sea, it is included in that marvellous depression to which the latter belongs, and is itself probably not less than 600 feet *below* the level of the Mediterranean, or 2800 feet below Jerusalem. Its mean temperature may therefore very probably be as high as 72°, equal to that of Cairo itself. The shores of the Dead Sea are not less than 1300 feet below the Mediterranean, and must consequently have an almost tropical temperature. We are therefore not surprised to find that, next to Jericho, Engeddi, on the western coast of the Dead Sea, and one of the few fertile spots (being well watered†) in that desolate region, is mentioned in Scripture as characterised by the palm, its other name being Hazezon-Tamar, meaning, "the felling of palm trees." (See 2 Chron. xx. 2, and Ecclesiasticus xxiv. 14.) The Rabbinical writers, according to Reland and Stanley, describe the palm as a tree of the valleys (*Stanley's Palestine*, p. 145), no doubt because it grew there in perfection; although it also occurred, perhaps

* According to Humboldt, 1° of latitude in temperate climates raises or lowers the temperature as much as about 270 English feet of change of level would do. (*Kosmos*, vol. i.)

† Stanley, p. 147.

in single trees or small groups, near Ramah (which is intermediate in elevation between Jericho and Jerusalem), Judges iv. 5. Palm trees also grew near Jerusalem, probably on the Mount of Olives (Nehemiah viii. 15; John xii. 13); but, though used to grace processions, there is no evidence of their being numerous, still less of their bearing fruit. It is remarkable that the references to the palm tree in Scripture are almost exclusively confined to its stately and ornamental character, and rarely, if ever, as to its fruit; the vine and fig being the favourite symbols of luxuriance in this respect. Indeed it is more than doubtful whether the date-fruit is ever referred to in the Bible. The marginal reference to it in 2 Chron. xxxi. 5, as Professor Mitchell informs me, is by no means conclusive, and the derivation of the name *Bethany* may not be "the house of dates," as believed by some high authorities; and even if it be so, the word is regarded by Hebraists as signifying the fruit in a *green*, not a ripe state, when it was used by the ancients as a condiment. It cannot, therefore, be safely assumed that the date *ripened* at Bethany.

I have only space to add, that the accounts of modern travellers confirm these inferences. They all agree that the palm is now rare in Palestine; that in the hill country of Judæa these trees occur only two or three together, and rarely, if ever, bring fruit to maturity (Shaw). They also agree that their disappearance in the valley of the Jordan is due not to the unfitness of the soil and climate to support them, but to the depopulation of the country, and to the rough treatment of the Arab tribes. Dean Stanley gives us the interesting information that the palm forest of Jericho was once eight miles long, "of which large remains were still visible in the seventh century and the twelfth, and some even in the seventeenth; and of which relics are still to be seen in the trunks of palms washed up on the shores of the Dead Sea, preserved by the salt with which a long submersion in these strange waters has impregnated them."* There cannot be the smallest doubt, from the meteorological inferences which I have already

* *Sinai and Palestine*, p. 144. The last standing palm was seen as late as 1838. (*Ibid.* p. 301.)



made, that the valley of the Jordan is at present unexceptionable, in point of climate, for bringing the fruit of the palm to maturity.

The sum of all this part of our argument is, then, this, that the climate of Southern Palestine cannot have been sensibly *colder* in ancient times than at present; and that the evidence from the habitudes of the palm tree coincides exactly with the historical proofs of its distribution.

But it may be said that it might have been anciently hotter. This would not, however, be in accordance with what has been inferred, as to the preference given to the deepest valleys as favourable to the palm. But more direct evidence to this effect may be found from the facts of vine culture.

The vine was anciently, and even in modern times, more peculiarly the symbol of Judæa. "It was the emblem of the nation on the coins of the Maccabees, and in the colossal cluster of golden grapes which overhung the porch of the second temple; and the grapes of Judah still mark the tombstones of the Hebrew race in the oldest of their European cemeteries, at Prague. . . . The elevation of the hills and table-lands of Judah is the true climate of the vine; and at Hebron, according to Jewish tradition, was its primeval seat."* It would be waste of time to cite passages of Scripture in proof of what every reader knows—that such was the case anciently, and that no plant can be more characteristic of a climate than the wine-producing vine is of the province of Judæa in particular. In the hot valley of the Jordan, as Kitto remarks, we find no mention of it; it also appears to be less frequent and productive on the low lands adjoining the Mediterranean.

When we come to consider the bearing of these facts upon the question of thermometric climate, the solution is somewhat less precise than in the case of the date palm, which we have been discussing. It is no doubt true that the region of

* *Sinai and Palestine*, p. 162. It is stated, however, by Mr Henfrey (Johnston's Physical Atlas), that the native country of the vine seems to be Imeritia and Mingrelia, at the south foot of the Caucasus, and nearly 10° north of Jerusalem. Considering the elevation of Judæa, both statements may be correct.

Palestine is almost or quite the farthest south, in that particular quarter of the globe where the vine is luxuriant. We read, indeed, in the Old Testament, of the vine being used for vintaging purposes in Egypt; and numerous hieroglyphics attest that this was not an exceptional, but a common practice. No doubt, in modern times, the culture of the vine in Egypt is insignificant; yet this is partly due (as in the corresponding case of Palestine, where the artificial growth of the vine has much fallen off) to political causes, to the want of energy of the people, and to the religious objection of most of them to the use of wine. We have already shown that the valley of the Jordan has most probably a climate, at least, as warm as that of northern Egypt; and as this is unquestionably on or near the productive limit of the vine in approaching the equator, so vineyards might be expected to flourish on the mountains of Judæa, but to fail on the plains of Jericho. This, as has been shown, is the testimony which Scripture yields on the subject. It is confirmed by the reports of modern travellers; only it must be recollected that there is now no inducement for urging the production of the grape in districts abandoned to erratic and lawless tribes.

In the more purely scientific view of the question, it is to be observed that the "Equatorial limit" of the growth of plants is far less vigorously defined than the "Arctic limit." This is generally admitted; and the causes of it are sufficiently obvious. The northern limit is usually defined by two circumstances: first, the existence of frosts in winter sufficient to destroy the vitality of the plant; and, secondly, the deficiency of summer heat requisite to ripen the wood of the tree or to bring the fruit to maturity. Towards the equator, the increase of solar heat and the absence (in some countries) of sufficient moisture do not so suddenly produce their effect. And in the case of plants cultivated for human use, like vines, the influence of climate may be warded off by certain precautions as to exposure and the like.* Thus, we are told, that

* On the whole, it is difficult to add much to the facts about the southern limit of the productive vine which are relied on by Schouw—namely, that Von Bach places it in the island of Ferro (Canaries) in lat. $27^{\circ} 45'$, with a mean temp. of 71° Fabr. In Barbary the vine succeeds only on the coast. At Cairo,

the vine may be brought to bear fruit in Egypt, in Southern Persia, and even in Hindostan, by planting it in pits sheltered from the rays of the sun. In most countries, too, there are spots exceptionally cool and moist, where, under proper care, cultivation may be carried on with even more than usual advantage, because the benefits of a fine climate may be obtained without its drawbacks. Of this description, most probably, was the locality of Engeddi, which is believed to have adjoined the western shores of the Dead Sea, and is still marked by a splendid spring which no doubt gave its name to the spot. In one place in Scripture* (2 Chron. xx. 2), Engeddi is characterised as productive in palm trees; and in another (Cant. i. 14), as distinguished by choice vineyards. Had the climate of Palestine in the days of Solomon been hotter than it is now, it is fair to infer that the culture of grapes in this the most southern, the lowest in point of level, therefore the *hottest* part of Judæa, would have been impossible. Besides, if we may be allowed to draw an inference from the climate of the neighbouring country of Egypt, the importance of grape culture, attested there by the Old Testament writings, and by the numerous and characteristic hieroglyphics which Kitto has transferred to his work on the "Physical Geography of Palestine," leads us to the conclusion that the climate there might be esteemed to have anciently been *more* adapted to that culture, therefore cooler, certainly not *less* adapted, that is, hotter, than it is at present.

To sum up the whole, we seem to be entitled to conclude—

1. That, judging from the known thermometric conditions of the growth and maturity of the date palm, compared with the evidences in Scripture of its distribution and culture in Ancient Palestine, the mean temperature of the site of Jerusalem, when reduced to the level of the sea, can have then differed but little from 70° Fahrenheit, which is its present value according to the best authorities. We conclude, with

with a mean temp. of 72°, the culture is insignificant. These facts point to the coincidence of the southern limit of the vine with the isothermal line of 72° which we have seen to pass a little to the south of Palestine.

* Hazazan Tamar signifies "felling of palm trees." Comp. Ecclesiasticus, xxiv. 14, "I was exalted as a palm tree in Engaddi."

still more certainty, that the temperature could not anciently have been *colder* than this.

2. That, comparing the conditions which limit the cultivation of the vine, we find that as it certainly was not anciently less, but *more* general and advantageous than at present, the climate of Palestine could not have been materially *hotter* than that which now belongs to its geographical position, taking also into account the modifying influence of height above the sea-level.

3. That this argument is enhanced by the evidence from hieroglyphics, and also from Scripture, that the cultivation of the grape was anciently more extensive in Egypt than it is now. That while this might be seen to point to the conclusion that these countries are *hotter* now than formerly, the difference is sufficiently accounted for by political circumstances, and the conclusion is itself negatived by the evidence to the contrary derived from the date palm.

4. Hence the climate of Palestine, being neither sensibly hotter nor colder than it anciently was, is, of course, unchanged; and the direct evidence of modern travellers on the distribution of the vine and palm in that country, leads to the same result.

TABLE I.—*Mean Temperatures referred to in preceding Paper.*

	Latitude.	Elevation. Feet.	Mean Temp.
Beyrout, ...	33° 48'	0	69°·4
Jericho, ...	31 50	— 600	72·0
Jerusalem, ...	31 46	2,200	62·6
Engeddi (Dead Sea), . .	31 30	— 1,300	?
Cairo, ...	30 0	40	72·2
Ferro, (Canary), . . .	27 45	0	71

TABLE II.—*Limits of the Date Palm.*

	Mean Temp.
First limit: Palm in full fruit—TUNIS, ...	68°·5
Second limit: Palm in flower—ALGIERS, PALERMO, . .	63·7
Third or extreme limit of growth—NICE, ROME, . .	60·0

Does Magnetism possess any Influence over Organic Forces?

By H. F. BAXTER, Esq.*

The most inattentive observer of natural phenomena would soon be led to infer, that between the variations of the seasons and the development of organised bodies, whether plants or animals, a most intimate relation and connection existed; that between heat and light on the one hand, and vegetation on the other, the connection would be found, upon the least reflection, to be so intimate and dependent that the former might be considered, in ordinary language, as the cause of the latter. No special observation, by means of experiment, would be requisite to confirm this conclusion. It is far otherwise, however, with regard to phenomena in which no periodicity or variation during their occurrence is observed; influences may exist, and be producing powerful effects, and yet, from their constant action, be entirely overlooked,—here, it need not be remarked, we require specific observation for their elimination. Now, since the discovery of diamagnetism, and the fundamental fact that *all* substances whatever are subject to magnetic influence, the conclusion that terrestrial magnetism must exercise some most important part over natural phenomena is irresistibly forced upon our minds. To solve one of the questions which naturally arise from this conclusion was the object of the present investigation; and although the results were negative, from the inadequacy of the means employed, the principles upon which the experiments were conducted may perhaps be of some value, and worthy of publication; but a minute detail of the experiments themselves may not be necessary, and will therefore be omitted.

Becquerel,† in some experiments upon the influence of electricity over the circulation of the sap in the *Chara*, placed a stem of the plant in a helix traversed by a current of electricity, so that the convolutions should be either parallel or perpendicular to the motion of the sap; but no influence appeared to be exerted over the circulation of the fluid.

* Read before the Edinburgh Botanical Society, March 13, 1862.

† *Traité de l'Electricité*, t. vii. p. 250.

Dutrochet* submitted a plant (Chara) for ten minutes to the influence of a powerful electro-magnet (which could support about a couple of tons weight), without any effect being observed upon the motion of the fluid.

Wartmann† says, "that one of the principal objects of his observations has been that of the influence of electro-magnetic induction on the circulation of the sap and the direction of the organs;" but has not, so far as I am aware, published his experiments or the results.

The experiments of which the following are the results were undertaken during the years 1852, 1853, 1854, and 1855; and it was during this inquiry that the question arose as to "the influence of magnetism over chemical action," which formed the subject of two papers that have already appeared in this Journal;‡ and in these papers will be found described the magnet and electro-magnet that were employed on the present occasion. Although the results of the experiments recorded in the present paper were, for the most part, obtained prior to that inquiry, they may nevertheless form a natural sequel to it. Their publication has been delayed from a hope that some more positive results might, on further investigation, be obtained; but the want of the necessary means, and the expense attending the prosecution of the experiments, were such that the inquiry has, for the present, been reluctantly abandoned.

As it may be considered a law in vegetable physiology that all plants have a tendency, during the germination of the seeds, to develop in two diametrically opposite directions (the root and the stem), the question arose, might not this direction be altered or counteracted by submitting the seeds whilst germinating to the influence of magnetic force? The experiments will be arranged under two heads: *First*, those in which the line of magnetic force was directed *perpendicularly* to the seed; and, *secondly*, those in which the line of force was directed *transversely* to the seed.

* Comptes Rendus, t. xxii. p. 621 (1846).

† Philosophical Magazine, 1851, p. 378.

‡ Edin. New Phil. Jour., New Series, vol. v. p. 225; vol. vi. p. 25.

§ 1. *Line of Magnetic Force perpendicular to the Seed.*

The large magnet was placed on a table horizontally, $3\frac{1}{2}$ feet from a window looking west—the marked pole uppermost.

The seeds of various plants, such as mustard, cress, rape, radish, peas and beans (broad), were made to vegetate in two boxes, one of which was placed between the poles of the magnet, the other out of the magnet's influence, but subject, in other respects, to similar conditions. In whatever way the experiment was varied, there was no effect observed that could be attributed to the result of the magnet. The influence of light over the direction of the plant was very decided, and almost led, at the commencement of the inquiry, to the supposition that the results might be due to that of the magnet; but upon removing this source of interference, by screening the plants from the light, the effect ceased.

The beans (broad) were planted with the hilum and micropyle directed in every possible way. They were also made to vegetate in water, being suspended by means of threads, without any effect upon the *direction* of the radicle or plumule being observed.

The lines of force were concentrated by means of a bar of soft iron, so as to lessen the space between the poles; the results were the same.

The beans were made to vegetate in water, supported by means of pieces of cork, so as to render them moveable, under the supposition that they might take up some definite position in the magnetic fluid, but no effect was observed. Great difficulty, however, was experienced in these experiments in consequence of capillary action. If the vessel contained more than one seed, they were frequently drawn towards each other; or, if the vessel was small, they floated towards the sides. Some of the effect might have arisen from diamagnetic action driving the mass outwards. There was another circumstance which interfered with the results; as the plant grew, the stem, becoming heavier than the root, leaned more or less to one side, until it was completely overbalanced.

As *time* forms an important element in the consideration of

the results, there is one circumstance connected with these experiments which must not be overlooked—viz., the difficulty in procuring a standard of comparison. It was impossible to get two seeds to vegetate and grow exactly alike,—for the buds and roots to appear at the same time,—although the greatest care was taken to obtain them of the exact weight, size, and appearance. Any one might easily have been led to the conclusion, that vegetation was either increased or rendered more rapid under certain conditions of the experiment than in others, had it not been checked by counter experiments.

The seeds were now made to vegetate around the poles of a magnet in the following manner:—Two circular stout bars of soft iron formed the terminals of the poles, and which could be separated to different distances at pleasure. The lower one was passed through the bottom of a flower-pot containing mould, in which the seeds vegetated; no effect was observed. An absence of the roots in the beans, on the sides contiguous to the pole, was observed; but as this fact was also noticed under other circumstances, when the seed was growing near to a solid body, it could not be referred to any repulsive action on the part of the magnet.

The beans were made to vegetate in water, instead of the mould, being suspended by means of corks or thread; no effect. The vessel was placed on the pole, and the upper pole over it, without any result being obtained.

§ 2. *Line of Magnetic Force transverse to the Seed.*

The first experiments were undertaken with Professor Wheatstone's large electro-magnet, but the difficulty in procuring and maintaining a *constant* force rendered the results doubtful.

The large magnet was now placed vertically, the marked pole being south.

A long, deep, but narrow trough, with moveable glass sides, which fitted into grooves in a wooden frame, was now employed; the space (the width) could be adjusted to a quarter, or half an inch, or to one inch, and its length was two feet, so that a portion could be placed between the poles of the

magnet, whilst the remaining portion extended beyond the influence of the poles. To concentrate the magnetic force, two soft iron bars, or rather plates of iron, were so adjusted as to form the terminals, and prevented from coming into immediate contact by pieces of wood.

The seeds were made to vegetate chiefly in mould, and in several experiments some effect appeared to be produced; the mustard or cress which was growing in the part between the poles was occasionally higher than in that portion out of the influence of the poles. This effect, however, appeared to be due to the influence of the light; for when the outer portion of the trough was screened from light by means of pieces of wood, the differences were not observed.

Beans were suspended in various directions, and made to vegetate in water, the trough having been made water-tight. No roots or mere prominences appeared on the sides in contact with those of the trough, but similar appearances were observed in those seeds that were out of the magnet's influence.

The experiments were varied by arranging the magnet with the marked pole north, then east, and then west. The results in all these instances were similar.

We should certainly not be justified, from these negative results, in coming to the conclusion, that magnetism is without any influence whatever over vegetation. I am far more disposed to conclude that the forces connected with the plant and its development are of such a nature as to resist the power of the magnet that was employed, and therefore would require more powerful means to make any effect perceptible. The reasons for forming this opinion may be gathered from my concluding observations.

Concluding Remarks.

It must be borne in mind that the present investigation comprises the question, whether Magnetism in a quiescent state (*i e.*, not in motion) has any influence over vegetation? Whether Magnetism when in motion has any influence, is another question. I will confine my observations first, to the former.

"It is a curious sight," says Faraday,* "to see a piece of wood, or of beef, or an apple, or a bottle of water, repelled by a magnet, or, taking the leaf of a tree and hanging it up between the poles, to observe it to take an equatorial position. Whether any similar effects occur in nature among the myriads of forms which, upon all parts of its surface, are surrounded by air, and are subject to the action of lines of magnetic force, is a question which can only be answered by future observation." My object has not been to develop the facts connected with the phenomena usually termed *diamagnetic*—that is to say, the influence of magnetism upon masses; but to study the influence of magnetic force upon other forces whilst in action, and to ascertain whether or no the *structure* of bodies might not be governed in their formation by it. Professor Tyndall,† in a paper entitled "On the Nature of the Force by which Bodies are Repelled from the Poles of a Magnet," relates some experiments respecting the magnetic properties of wood. Of thirty-five specimens examined, he found that they all took up a definite position in the magnetic field; the line coinciding with the direction of the fibre being equatorial (*diamagnetic*); only one specimen (bog oak) taking up the axial position—and this was due to the extraneous matters (iron) with which the wood was impregnated. The different woods varied in their power of set, but they evidently showed an intimate connection to exist between the structure of the wood and the line or direction of the magnetic force. Let us consider for a moment the general facts connected with vegetation. We have plants growing upon a large magnet, the earth, and therefore under the constant influence of magnetic forces. There is every reason to believe, for experiment proves it, that the actions which take place in plants, viz., nutrition, secretion, and absorption, are accompanied with the development of electrical currents; and wherever electric currents are developed, we know that magnetism exerts a directive influence over them. There is no reason to suppose that magnetism initiates or originates these currents unless motion is superadded. Instead, therefore, of considering the ascent of

* Experimental Researches, vol. iii. para. 2451.

† Philosophical Magazine, 1855.

the stem as an instance of diamagnetic repulsion, is it not more likely and probable that the organic actions of the plant—secretion, nutrition, and absorption,—under the influence of terrestrial magnetism, are so far governed as to be obliged to take up a certain line of direction, the resulting effect terminating in the form and mode of growth which we find plants to assume? These may be looked upon as wild notions; but the real point is, are they true or false?

With regard to the other question, viz., What grounds have we for supposing that magnetism when in motion may have some influence over vegetation? as I am not aware of any experiments having been undertaken for the purpose of elucidating this point, let us refer to facts which bear upon it. Whenever a closed circuit of conducting matter, whether metals or otherwise, cuts or intersects magnetic lines of force in certain directions, a current of electricity is evolved in that circuit. It matters not which is in motion, the circuit or the magnet; and therefore, if a tree be in motion or a man be walking, and intersecting the magnetic curves or lines of magnetic force of the earth, and *if* there are closed circuits of conducting matter within his body or within the tree, electric currents are necessarily developed. Now we know that there are electric currents developed in the animal body as well as in plants, independent of magnetic influence.* I do not suppose, as was said just now, that magnetism *originates* these currents in plants, and therefore not in animals; but I think it highly probable, that both in plants and animals, whilst intersecting the magnetic curves of the earth by motion, that the same influence may be exerted over these currents, either by increasing them, if in the same direction, or by lowering their intensity if in a contrary direction, or if the tendency to their formation be too weak, by then aiding the actions for their formation. With respect to plants, Knight† has related some experiments, in which a tree was made to move to and fro in one direction, in a segment of a circle, and he found upon examining the tree afterwards, that it was thicker in the line of motion than in any other direction, in the proportion

* Essay on Organic Polarity. Churchill. 1860.

† Physiological Papers.

of 13 to 11. This result he attributes to motion ; and he also alludes to exposed trees, agitated by winds and storms, as presenting a difference in their structure and growth as compared to those of an unexposed forest tree. I will ask this question, May not these results—I will not say they are—be due to the circumstance, that during the motion the magnetic curves of the earth are intersected, and consequently the various actions which take place in the plants—viz., secretion, nutrition and absorption—are influenced by the electric currents that are called forth within it ?

The same observations may be made in regard to animals. Theoretically speaking, motion of parts, or in other words, exercise, ought to show some results ; and does not experience prove this ? Look at the blacksmith's arm. Nature never intended the plant, much more the animal, to remain in one constant position ; an intersection of the magnetic curves of the earth may perhaps be as necessary a condition, if not for vital action, still for the development of the different forms that are observed in substances possessing structure, as the influence of heat and light is found to be for the development and maintenance of that action.

P.S.—Since writing the above paper, I find that the subject, "The Influence of Railway Travelling upon Individuals," has been brought before the attention of the medical profession in the "Lancet." It would be premature to say how far any of the effects that have been observed may or may not be due to the intersection of the magnetic curves of the earth, until we know more of the nature of the influence that might be exerted.

Observations upon the Production of Colour by the Prism, the Passive Mental Effect or Instinct in comprehending the enlargement of the Visual Angle, and other Optical Phenomena. By J. ALEXANDER DAVIES, Esq.

The doctrine of the decomposition of white light by the prism, and indeed of coloured light, may be said to be one with

which philosophers generally, perhaps universally, agree, and this apparently on the ground that the colours produced cannot be occasioned otherwise than by the decomposition of the incident visual ray, which for this purpose they suppose, or assume, to be compounded, following the example of Newton; whereas the fact is, that the production of colour in this way admits of two possible explanations—two possibilities as to its cause,—a fact which either has not occurred to them, or which they have not thought proper to acknowledge. I do not undertake to affirm that the present doctrine of the production of colour by the prism is not the probable one, and only wish to point out that the idea of its necessary exclusiveness is a philosophical error.

As has been observed, the idea or hypothesis of Goethe, that the several colours are produced by the successive weakening of the luminous undulations surrounding us, the gradual attenuation of the solar rays, is one to which more attention should be directed. The fact that colour can be produced by means in which no prismatic effect can be discerned, or perhaps conceived—as when the sun is viewed through a piece of smoke-blackened glass,—affords some presumption for supposing that the production of colour by the prism is not occasioned by decomposition, and this especially, when it is considered how difficult it is to conjecture how the prism effects the disintegration of the incident light. However, difficult as this is, it is not perhaps more difficult than to imagine how a triangular-shaped piece of glass so weakens (the attenuation varying with the several rays) the light falling upon it, so that the one objection is balanced by the other. Still, two possibilities must be admitted, if we would investigate in a logical or philosophical manner. It has not, I think, been observed by philosophical writers, that, to explain the phenomenon of the prism upon any hypothesis, it is absolutely necessary to suppose a reverberation of the incident rays, which, if not allowed, it must be admitted, absurd as the admission would be, that they are furnished with a species of sense. When a ray, or rather a small beam of light, seeing that it is not possible in any case to admit only one ray upon an object, falls upon a prism, it is, on account of the want of parallelism of the opposite side, decom-

pounded upon passing through it, the various coloured rays suffering more or less refraction, which could not be the case unless the want of parallelism were experienced before the side were reached, inasmuch as this would be an effect without a cause; seeing which it must be concluded that the beam of light first passes to this side, being only reflected, and, after suffering the effect of it, is reverberated back,—a process which may not coincide with ordinary reflection,—and again passes through, thus suffering decomposition, or, on the other hypothesis, having its several rays variously affected. Upon either, it is very difficult to imagine how the important alterations are effected; how, upon the one, decomposition, and, upon the other, various affections or dispositions of the several rays, is the result of the incidence of the beam upon the second side of the prism, that is, relatively regarded. Unless, perhaps, by reflection against its upper side, the coloured rays could not reach the place of the entrance of the white beam,—an action which I do not suppose, thinking it probable that by a species of retrogression, which may be called reverberation, the coloured pencils are produced, which reverberation may or may not coincide with ordinary reflection, as regards the visual angle being always equal to that of the incident ray, but must at any rate be set down as having the effect of producing them. That the coloured pencils are produced merely by ordinary reflection from the second side, is a supposition almost unallowable. Before proceeding to other considerations, I must refer to one phenomenon of the prism, the immediate explanation of which is not dependent upon that of colour generally, and which, if it has been explained at all, has been set down—and this, I apprehend, erroneously—as one of the phenomena of chromatic aberration; the phenomenon is, that only the contours and internal lines and points of objects and pictures, are coloured when seen through a prism, the ground in both cases appearing of its real colour. Now, chromatic aberration is only possible at those parts of objects the several coloured images of which are not near enough together to become blended, so that, if colour is found to exist where this must be supposed, it cannot, of course, be set down to this cause. This is the case with a prism; the parts immediately

beneath the eyes are homogeneous in colour, of their natural colour, if this is one, as also are all the other parts of the object or picture under this condition ; but if the parts beneath the eye have lines or bands of light or shade, or any other bands, lines, or points, these, and also the marks on the other parts, will be fringed with colour, the colours on the former parts not arising from chromatic aberration, the coloured images there formed being blended, by reason of their proximity ; seeing which another explanation is necessary. I take it that the uniformly coloured surface, which is not affected when seen through a prism, is so because the various rays reflected to the eye are united after being decomposed by it, and that the bands and lines in the parts immediately beneath the eye are prevented from being recomposed by reason of the disturbance of the surrounding colour.

The mental or instinctive action at work, when the rays reflected from any object are refracted in their passage to the eye, and also in the use of telescopes, microscopes, and other instruments, is a consideration which both demands and deserves a close inspection, and concerning which but little is yet, I think, understood. Whenever a stick under water is seen, it is known that its position is not what it appears to be, and the depth of its several parts may roughly be known, and both from knowledge previously acquired ; but, inasmuch as the direction at which the various rays enter the eye does not lead to the object, it must be concluded that the apparent object, or the image seen, is wholly either a mental or instinctive production, a something passively occasioned, and this by virtue of the rays proceeding from the object. Now, although the depth of the object is roughly known, and depth is one disposition of distance, yet it should be inquired how this knowledge regulates the mental or instinctive limitation of the angular space made by the visual rays. That this limitation is made in every case of reflection and refraction is obvious, inasmuch as otherwise no idea could be formed either of the distance or the size of an object ; and the question is, how it occurs in consequence of the visual rays, or the angle subtended by the eye, for that it does thus occur is a fact concerning the truth of which no discussion can be made. When the reflec-

tion of an object before a mirror is seen, it is at once known what is its size and distance—at any rate, if it is of a kind with which the spectator is acquainted, perhaps in every case, these points being determined by a reference to the various conditions which are known to give them; nevertheless it is not clear how they give rise to the limitation of the angular space: and so as regards the telescope, microscope, and other instruments, and all the phenomena of refraction; the visual angle is increased, yet it cannot be said how the limitation, upon which the apparent nearness depends, is regulated, except by referring it to a passive mental action or instinct, which are terms which suggest little meaning. That there is not any physical barrier to the prolongation of the angular space is clear; and, inasmuch as the impressions upon the backs of the retinas (which are only intermediate effects of the light in its passage to the nerves, and which, therefore, it does not appear are alone the things seen, or mentally experienced, by means of the visual rays, but that they never are viewed, the objects themselves, from which the rays ultimately proceed, or are reflected, being apparently what are always visible, which explains why their appearance is always according to the tactual sense, or erect) are not phenomena having this effect, not being even appreciable functions of the distances and sizes of objects, the limitation must be set down as being brought about by one of the before-mentioned causes. It may be supposed that it is physically produced by virtue of the two eyes, by means of which two sets of rays are seen in reflection and refraction, which in the former case converge apparently to a point, and in the latter really meet, or are reflected from the various points of the object; but this cannot be the case, seeing that it is produced when objects or reflections are seen only with one eye.

The light proceeding from luminous objects is in every case accompanied with something which produces the sensation of colour, a different thing, and the intensity of which is therefore a different condition, from that of the light; and as regards what is ordinarily known as colour, there is one very important question, which is, how its intensity is increased and diminished. A thin mixture of Indian ink is of a brown

colour, and its lightness is increased by every accession of water ; and hence it must, I think, be concluded, either that the brown colour is caused by the very thin distribution of black particles, or that the black arises from the great compactness of ones almost if not quite infinitely light,—of which suppositions I take the former to be the probable one.

The fact that black polished surfaces reflect very little light, however great the approximative perfection of the polish, enables us to draw a very curious conclusion, which is, that their colour to a great extent counteracts their reflective property, and this not mechanically, which method would be by preventing them from receiving a good polish, for this they may have, but by some disturbance at their surfaces, the nature of which has not yet been discovered : the quality of a surface of black marble, for example, by which its colour is formed, does not affect its hardness ; and yet, when polished to the utmost, the amount of light reflected from it is much less than that reflected from off a white surface, of equal polish, of this material.

The apparent increase in the size of the sun and moon, when near and upon the horizon, are phenomena in explanation of which various considerations have from time to time been put forth in the Philosophical Transactions, and elsewhere, for which reason some may look upon it as hopeless further to attempt their explanation : I have thought, however, that it would be of utility to set forth an experiment which I have made, which I shall now do, and make a few observations thereupon. I am not aware that it has already been given, and submit that it shows that the dulness of these objects in the situations alluded to, is, at any rate, one cause of their then being considered to appear larger than when in or near the zenith : I say considered to appear, because the angle submitted by the eye being always sensationally the same, the differences being far too minute for sensational apprehension, the various estimations of distance, and consequently of size, are in every case either mentally or instinctively produced. If any ball, as a marble, is suspended against the light by a fine silken thread, as before a window, for example, and viewed at the distance of about thirty feet, it will actually be con-

sidered to appear to be larger than it would if seen in the hand, or above the size which the sense of touch would give, and, as may be supposed, the side next to the spectator would appear dark, which might in some cases be altogether the effect of contrast, as the light reflected from off it might not be sufficiently intense to make any sensible impressions upon the eyes ; but if it is viewed at this distance from outside the window, or when suspended to this height in the air, in both of which positions the light would directly fall upon the side next to the spectator, it will not be considered to appear appreciably smaller than it would if looked upon in the hand. It follows, I take it, that the apparent increase of the size of the ball is caused by its being supposed to be at a greater distance than is really the case, and this consequent upon its dulness, which supposition is, I apprehend, possible, the mind not being able to get rid of or throw off the conclusion which dulness, or want of luminosity in an object, always engenders, and would, of course, lead to the conclusion that it is larger than it is ; and therefore, that the inferior luminosity of the sun and moon, when in the positions mentioned, produces the same mental impression, which impression is found to exist, although, as also in the case of a ball, the necessarily previous idea of greater distance can scarcely, if at all, be caught. It may, from this experiment, be concluded, that the fact of large distances not being realizable by the mind, is not, at any rate, wholly the cause of the mental confusion which has been alluded to, and also that the ball appearing darker, and being considered larger the greater the distance from which it is seen, these objects are set down as larger in proportion to their increase of dimness, which is always the case. It cannot be denied that there is a considerable difficulty in understanding how, the distances of objects being known, whether or not they are realized, the circumstance of dimness forces the mind to consider them farther off,—nevertheless the thing cannot be set down as impossible; besides which, the supposed early persuasion, by which objects in a horizontal direction are looked upon as farther off than those at the same distance in a vertical direction,—this fact being supposed to be known to the spectator,—is also fraught with it, which fact, however, is

not, of course, of any assistance to the conclusion which has been made from the present experiment, and which, in itself, is not a new one.

*On the Connection between Organic Force and Crystalline Force.** By H. F. BAXTER, Esq.,†

My previous researches having led to the conclusion that the *force*, associated with organised bodies, plants and animals, is a *polar* force, the question would naturally arise, Is there any connection between organic force and crystalline force, —between organic polarity and crystalline polarity?

It might be easily shown that some of the greatest physiologists and naturalists have felt some difficulty in drawing a definite line of demarcation between crystallisation and organisation; and I believe the facts principally adduced to establish the characteristic differences are merely those connected with the mode of growth and development. Any one, however, who had not reflected much upon the subject, would be firmly convinced, and reasonably so, in his own mind, that between a plant and a crystal the differences were so great that no relationship could by any possibility be established between them. To refute this opinion, which appears to me to be fallacious, will be the object of the present undertaking.

Let us first endeavour to obtain some clear ideas regarding crystals and crystallisation, and the nature of the *forces* concerned.

Crystallisation.—*Crystallisation* is the symmetrical ar-

* Read before the Royal Society of Edinburgh, March 3d, 1862.

† In the present paper I have quoted freely from Professor Whewell's work "On the Philosophy of the Inductive Sciences," regarding the subject of crystallisation, and I ought in justice to that individual to have marked the passages thus quoted; but as I have endeavoured to condense some of the passages, I may unintentionally have rendered some of his expressions indistinct, and therefore make him responsible for views which he may not entertain. The same remarks may be made in regard to Professor Faraday, whom I have quoted on the subject of magne-crystallic actions.

I would call the attention of my readers to the chapter in Professor Whewell's work on "The Connection of Polarities." Professor Whewell has not alluded to the subject of organic forces or organic polarity, and I have endeavoured to show in the present paper that the time has arrived when these forces must be brought within the same category.

rangement of the particles of a body when it passes from the gaseous or liquid to the solid state; the solid body thus formed is termed a *crystal*.

The force, of which solidity, cohesion, and crystallisation are the result, is that which gives to crystals their permanent existence and their physical properties. This may be called the *power of crystallisation*, or the resultant effect of the exercise of *crystalline force*.

One of the most important physical properties of crystals is their geometrical form, or arrangement of their elements in space; and in crystallography crystals are arranged into different systems, according to the degree and kind of symmetry which their primitive forms possess. The primitive forms of crystals are few, but the secondary or derived forms innumerable.

There are different kinds of symmetry,—we have three-membered, or *triangular* symmetry; four-membered, or *square* or *tetragonal* symmetry; *oblong*, or *two-and-two-membered* symmetry; *simple* symmetry, and the *cubical* or *tessular* symmetry.

Now, the parts which are termed symmetrical resemble each other not only in their form and position, but also in the mode in which they are produced and modified by natural causes; and it may be stated as an axiom, that *all the symmetrical members of a natural product are, under like circumstances, alike affected*. In the increase, development, or growth of a crystal, all the incidents of form must affect alike all the corresponding symmetrical parts.

With regard to the nature of the *force* by which the crystal is formed, it is not simply that of *attraction*. The *force* by which crystals are formed is *polar* in its character. If two atoms, A B, adhere so as to form one particle, the line A B which joins their centres must have some position in space. It may be considered as an axis (axis of symmetry), the poles of which are A B. The polarity of the particles of crystals has reference to their geometrical form. The poles in crystal are not constituted with *opposite*, but with *similar*, properties; and one of the characteristics of crystalline polarity is this, that *the opposite faces make the same definite angle with an axis*.

That crystalline polarity, and chemical polarity, are merely different modes of manifestation of one and the same force, may be inferred from the following arguments:—The two forces, crystalline and chemical, are identical; it is only definite chemical compounds, or simple bodies, that crystallise, we cannot distinguish and separate the force which constitutes the body, from that which forms the crystal. We need not, therefore, suppose that crystalline polarity *must* present the same character as electric polarity, viz., the *contrast* of properties, for we may have the force chemical existing under two distinct conditions—either in the *static* form, as in the crystal, or in the *dynamic* form, as current force during chemical action.

Here, then, we have the polar character of crystalline force established. In the crystal the force assumes the *static* form; but whether, during the formation of the crystal the *current* form is manifested, I am not prepared to say. The experiments of Becquerel, in which crystalline compounds were formed, the formation of the crystal may be considered as due to the electric current that was employed. Be this as it may, they only show the mutual dependence of the one upon the other,—the formation of the crystal, and the existence of the electric current.

It need be scarcely remarked, that for the growth and increase of the crystal we are compelled to assume the pre-existence of the compound, generally in the form of solution. Crystals grow by the addition of particles, and so do organised bodies. Crystals may be said to select their particles, and so do organised bodies. But it is in the development of the germ, and that of a crystal, that the greatest differences have been noticed. In crystals, the particles are added to the surface, whilst in the plant or animal the matter is taken within by “*intus-susception*.” Again, in crystals, we have plane surfaces and angles, but in the organised body we have rounded surfaces. Having thus far discussed the subject of crystallisation and crystalline force, let us now turn our attention to that of organisation and organic force.

Organisation.—I shall assume for the present that there is one condition of “*organisable*” or “*viable matter*,” which

bears the same relation to organisation, as crystalline matter—the crystal—does to that of crystallisation, and shall speak of it as the “germ.” Whether this “germ” consists simply of “blastema,” “protoplasm,” “germinal matter,” or of a “nucleated cell,” it will not be necessary for me to decide just now; but it will be considered as being derived from a pre-existing organism, just as a crystal was developed from pre-existing crystalline matter. This germ, then, may exist under two conditions; 1st, In a state of quiescence, as in a seed; or 2d, In a state of development, as an organism or living thing; and the force connected with it, whether we call it germ-force, cell-force, or organic-force, may also be considered under the respective circumstances as existing either in a static condition or in a dynamic condition.

Now, this germ does not grow and increase in size, like the crystal, by the mere addition of similar parts, but undergoes a *transformation*, the parts becoming differentiated. The crystal may be considered as constituted of a mass of germinal matter, which remains as such, and thus builds up the crystal; the organism, on the other hand, consists of germinal matter, undergoing, under certain conditions, a series of changes, the resultant effect of which is the growth and development of the individual organism. But this organism, like the crystal, is developed according to laws of symmetry, which may be either *simple* symmetry, *triangular* symmetry, or *pentagonal* symmetry; although this last, *pentagonal* symmetry, has been considered by Agassiz, I believe, as resolvable into *simple* or *bilateral* symmetry.

It will not be necessary to pursue further the changes that occur during the development of the organism, these I shall allude to in my concluding remarks, but let us now endeavour to get some clear idea regarding the nature of the forces concerned in these actions. I must refer to my previous papers* for the evidence upon which I have come to the conclusion that the actions which take place in the living body during growth and development are *polar* actions, for they are accompanied with the same manifestations of current electricity

* Essay on Organic Plants. Published by Churchill. London, 1860.

as ordinary chemical actions, and therefore the force associated with the organism—organic force—is a polar force.

Here, then, we have a most intimate relation or connection established between organic force, chemical force, and crystalline force; so far as they are *polar* they are identical.

Since the different forms of polar force are so intimately related and connected with each other, it becomes important to ascertain in what manner the crystalline and organic form of force are related to other forms of polar force, and especially to the magnetic.

§ 1. On the Influence of *Magnetic force upon Crystalline Bodies.*

If we take a crystal of bismuth, and suspend it between the poles of a magnet, we shall find that, under certain conditions, the crystal will take up a definite position, and return to it when moved. If we suppose an imaginary line to pass through the crystal, this line in bismuth being from one obtuse solid angle to the other, and perpendicular to the brightest cleavage plane, it will place itself parallel to the magnetic lines of force, or in the *axial* direction; but if this crystal be moved, so that this imaginary line, which is called the magne-crystallic axis of the crystal, be placed in a vertical position, the *setting* power of the crystal is gone, and the mere dia-magnetic effect remains. The law of action may be thus stated:—*The line or axis of magne-crystallic force* (being the resultant of the action of all the molecules) *tends to place itself parallel, or as a tangent, to the magnetic curve or line of magnetic force passing through the place where the crystal is situated.* The crystal does not possess the same properties as a magnet, viz., north and south points; for if the crystal be turned round into the diametrically opposite position, the same effect will ensue—there is neither attraction nor repulsion. The opposite ends of the crystal do not present opposite properties as a magnet; either end of the mass, or of its molecules, is to all intents and purposes, both in magne-crystallic phenomena, and in the ordinary results of crystallisation, like the other end; and in many cases, therefore, the words *axial* and *axiality* would seem more expressive than the words *polar* and *polarity*.

We must not consider this imaginary *line of force*, or *magne-crystallic axis* of a crystal, when in the magnetic field, as a real definite elementary line existing in the crystal as such; for it may be, and no doubt is, the resultant effect of the compound dispositions of the forces in the crystals; and the final *set* of the crystal in the magnetic field is due to the combined reaction of the magnetic and crystalline forces upon each other.

I shall not enter further into the deportment of the different crystals when placed in the magnetic field, and the theoretical views that may be entertained to account for the phenomena, as these may be found in the published papers of Faraday, Plücker, Tyndall, and others. My chief object is to show that there is a definite relation or connection between magnetic force and crystalline force, as manifested in the deportment of a crystal when placed in the magnetic field, the position of the crystal depending upon its structure.

§ 2. *On the Influence of Magnetic Force upon Organised Bodies.*

Professor Tyndall* has shown that organised structures, such as wood, when placed in the magnetic field, take up a certain and definite position, the line, coinciding with the direction of the fibre, setting in the equatorial position.

These facts (the deportment of the crystal and that of wood, when subjected to magnetic force, evidently depending upon the structure of the substance), may be adduced as further arguments in favour of the identity of the force both in crystals and in organised substances. It would, however, be extremely premature to establish this as a law, from the little experimental evidence that can be at present adduced in regard to the influence of magnetism upon organised bodies; but as far as it goes, combined with other arguments which have been adduced, it tends to establish their identity.

The relation between magnetic force and organic force is further shown in the development of current force during

* Philosophical Magazine. September, 1855.

organic action. Upon the connection between current force and magnetic force, I need not dwell.

Concluding Remarks.

The conclusion to be deduced from the foregoing arguments is the following:—That the force connected with crystals and organised bodies is identical, viz.—a *polar* force; and it remains now to point out the real distinctions that can be established between the formation of the crystal on the one hand, and the development of an organism on the other. This distinction is manifested in the mode of growth. In the crystal there is the simple addition of similar parts, the only condition being a supply of material, usually in the form of solution, for its growth and increase; whilst in the organised body, on the other hand, the growth is accompanied, not by a mere addition of similar parts, but the substance (the food) must be formed, and undergo transformation, before it can be added to the structure of the organism; and not only that, but for the perfect development of the individual there must be a series of changes,—the food must become sap or blood; and it is from this sap or blood that the perfect tissues are formed. Crystallisation may be said to consist in the deposition of homologous parts, according to the laws of symmetry, whilst in organisation, the parts, previous to their deposition, must undergo a series of transformations; so that life may be said to consist of a series of constant changes of organic matter, which result in the development of an individual organism.

Now, the real point for consideration is this, are we justified, from the mode of growth alone, in drawing a real and essential difference between organisation and crystallisation? To answer this question satisfactorily, we must consider the object we have in view.

In the classification of things as individuals, for the purpose of Natural History, our divisions are generally conventional, things are usually divided according to external differences and resemblances—*forces* are not alluded to, or are overlooked; and therefore we are apt to conclude, that a greater distinction exists in the nature of things themselves from the manner we view them, than exists in reality. In Physics and Chemistry,

forces are considered in an abstract manner, whereas, in Natural History, the objects themselves are studied; all that which cannot be perceived by the senses belongs not to its domain, the properties of bodies are considered abstractedly, but only as characters. It may, however, be stated, that if the same plan were pursued in regard to Natural History as in Physics and Chemistry, the mind would deal in abstractions so wide and general that no positive knowledge would by this means be obtained. To the justness of this observation no one can refuse assent. My object has been to show that between crystalline force and organic force no essential distinction can be drawn; but the mode in which these forces are manifested may at the same time present such differences as to lead, for the purpose of classification, to a distinction as individuals.

Hitherto I have confined my observations to the growth and development of organised bodies, and have assumed, as with a crystal, the pre-existence of organic matter; the question, however, arises, What is the primary form and constitution of organic matter; or, in other words, can organic matter be formed from inorganic matter? The primary form of organic matter has usually been considered as a nucleated cell; but I believe at the present day that this is not essential; the microscope alone cannot teach us what are the essential constituents of "viable matter"—this the chemist must do. When the chemist can tell us the constitution of organic matter in its first stage, at its first formation, then we may have some hope of being in a condition to answer the question satisfactorily. What the chemist has analysed are compounds formed during the process of organisation during the changes that take place in the growth and development of an organism. This will not answer our purpose; and until we can get some clear notion concerning the real constitution of the primary form of viable matter, we are stopped at the very commencement of the inquiry.

Professor Graham* has found it necessary to divide substances into *crystalloids* and *colloids*, and considers "the

* On Liquid Diffusion applied to Analysis. *Medical Times and Gazette* Aug. 3, 1861.

colloidal to be a dynamical state of matter; the crystalloidal being the statical condition. The *colloid* possesses *energia*. It may be looked upon as the probable primary source of the force appearing in the phenomena of vitality. To the gradual manner in which colloidal changes take place (for they always demand time as an element), may the chronic nature and periodicity of vital phenomena be ultimately referred." Let us take a portion of colloidal matter, and assume, for argument's sake (although no opponent might grant it) that, under certain conditions, this might become a portion of viable matter, and form a cell. Here we get the first starting-point of an organism. But what are our difficulties? Let us compare it with the development of a crystal. For the mere growth of a crystal we should only require a solution containing similar substances, but for the cell to grow and become a living organism, we should require the influence of another cell, either a germ-cell or a sperm-cell, and also to know the kind of food it would require for its development. To become a plant it would require a certain kind; to become an animal another kind; so that, for the perfect development of this cell into any particular kind of organism, it would require to be placed under different circumstances during its earliest stages, so as to produce the different forms and varieties that are observed in the organic world. A knowledge of the "conditions of existence" is therefore the great desideratum.

I do not feel the difficulty that is generally entertained regarding the supposition of the *origin* of organic matter from inorganic matter; it is usually, perhaps, from pre-existing organic matter, but I believe it may arise without assuming this mode of origin. The conditions for its development is the great difficulty. The germ, whether from pre-existing organic matter, or from other sources, if exposed during its earliest stages to certain conditions, may become developed into what we may term a different organism to that of its parent. It would be in the earliest stages, perhaps, that the differences would be more readily taken up. We know that a cell with or without a nucleus may be predicated as the starting-point of the whole range of the organic kingdom. And as we have no reasons for supposing that different forces are called into

action, excepting in the higher grades of development, but what exist in the inorganic kingdom, that there is no real and essential difference between the force connected with organised bodies and that connected with crystals, these facts would go far to prove the non-necessity of a fresh act of creation for each individual organism, as we should be compelled to assume the same necessity for each individual crystal.

On the Condition of the Salmon Fisheries of England and Wales in 1861; with a Notice of some of the Modes of Fishing, especially those practised in the Severn and Wye; and Remarks on the Natural History of the Salmon. By Sir WM. JARDINE, Bart., F.R.SS. L. & E., &c.

Introductory Remarks.

In the twenty-fourth year of the reign of Her Most Gracious Majesty Queen Victoria, a Royal Commission was appointed "To inquire into the salmon fisheries of England and Wales, with the view of increasing the supply of a valuable article of food for the benefit of the public."

The commissioners appointed were Sir W. Jardine, Bart.; Joshua Fennell, Esq., one of the Inspecting Commissioners of the Fisheries in Ireland, and George Kettilby Rickards, Esq., Counsel to the Speaker of the House of Commons; and they were efficiently assisted throughout by Frederick Eden, Esq., as their secretary.

These gentlemen met by arrangement at Gloucester on the 10th September 1861, and afterwards visited and inspected personally all the principal rivers and salmon fisheries in England and Wales, and took evidence thereon. They asked and received answers to 18,000 questions, printed in a Blue Book of 545 pages, and laid their report, for presentation to her Majesty, before the Home Secretary in the February following. This might have sufficed; but as blue books are fitted neither for railway reading nor for perusal from the pillow, and 18,000 questions would trench severely on time and the memory, and as the phraseology and limits of a report made under these circumstances

must be somewhat strict and concise, it has been thought that the information obtained, if given in another form, combining some notes upon the different modes of fishing employed, and on the natural history of the several species brought under observation, might not be unacceptable. An attempt to do so has now been made.

No subject has been more legislated upon than that of the regulation of the salmon fisheries of Great Britain and Ireland; and while this indicates the importance attached to them, it has been at the same time mainly caused by the want of a correct knowledge of the facts relating to them, by ignorance of the habits and natural economy of the species, and by parties looking at one or two insulated points only, instead of viewing the subject and the various interests connected with it as a whole.

In the early state of all countries the wild animals, birds and fishes, were killed for food, or to assist in clothing, indiscriminately at all times, and without regard to the seasons of breeding. The thinning out of these, sometimes their entire extirpation, invariably followed the increase of population in the older countries as well as in the new; and thus it was that their great economic value was early appreciated, and laws and regulations were framed for their protection during the breeding seasons, and to check what had become an abuse of the gifts of nature.

As wealth increased, other agencies came into operation. The immense extension of our manufactures and mining operations, and the various scientific appliances to these and to agriculture, all had their influence on the number of wild animals, while the machinery employed in mills and inland navigation especially interfered with that of those inhabiting the waters. As wealth advanced, so in proportion did luxury; game and fish must be had; as the facility for transport increased, the demand enlarged with it, and new contrivances for capture, "improved machinery," followed, to keep up with the extended calls. But a farm will only produce to a certain amount,—even with the greatest care and culture that has its limit; and if we look at the poultry and fish shops of London and the great manufacturing towns of Great Britain, and calcu-

late the enormous supply of game and fish there daily exhibited through the season, our fears that by-and-by we shall not be able to produce the supply required are not groundless. Add to this the demand at seasons not legally open, for export and otherwise, and the case becomes far stronger; and when foreign countries throw open their markets for game and fish at seasons when they are unfit for the market, and not legally saleable here, the temptation to transgress becomes stronger still, and we can scarcely hope by any means to keep up the supply. The salmon fisheries of England and Wales have suffered from all these causes, even though in most instances they are public property, and might have expected public protection. But they have been at all hands most shamefully neglected; the greater stakes have been sunk needlessly and without reason into the lesser, for commerce and salmon are quite compatible. Demand sharpened invention; more deadly engines swept the coasts and estuaries; retaliation harried the upper waters—as “few salmon were permitted to ascend, few should be permitted to return;” and the fisheries have reached that worn-out and wasted condition stated in the Commissioners’ Report. So it was that the cry of *over-fishing* got up: “salmon in England and Wales were getting extirpated;” and the record of large rentals from Scotland, and improvements in Ireland, induced the belief that something was wrong, and that a remedy was wanted. There is, however, no difficulty in the case. The salmon fisheries of England and Wales were just numerous farms, as badly managed as some land districts were thirty years since; it was all abstraction from the soil, without regard to return or rotation—it has been all abstraction from the fisheries, without regard to breeding or season. They are wrought-out farms, and require new tenants with enlightened views and such command of capital as will enable them to wait until the losses are repaired. The capabilities of the subject are excellent. Throughout all the abuse and waste, it has been able as yet not only to meet in a great measure the demand at home, but also to send out a large recognised export, while, at the same time, a clandestine export, at seasons most ruinous to the fisheries, has been carried on. The declared value of the export of salmon to France in 1860 was £1,10,000.

The clandestine export there is no means of ascertaining correctly, but it is widely spread and general, and from three to five tons are authentically known to have left Billingsgate Market in a single day.

A natural question arises, Why should England or Wales have been so long blind to their own bounties, while elsewhere large supplies of salmon were yielded to the great markets, and large incomes drawn? We do not presume that the English and Welsh families despise a good rental, and many of them are the best general sportsmen in the world; yet they undertake long journeys for the sake of good salmon fishing; they visit Scotland and Ireland, Norway, and even North America in search of sport, unconscious of what may be found in their own Wye, and Torridge, and Taw—or of what exists, perhaps, within a morning's easy ride, or even on their own properties! Various circumstances may have tended to cause this. The tidal fisheries in England and Wales are open to the public under common law right. The exceptions to this are not numerous, and rest upon ancient grants to the Church, or on some of later date to private parties; but the proprietor of the lands on each side of an estuary or tidal stream has not otherwise an exclusive right to the salmon fishery. He could and did fish under his common law right; but after fixed engines were introduced, and chiefly with the view of maintaining his title, he claimed a rent generally insignificant, for permission to drive stakes or fixtures into the ground; and he thus could not have a monopoly of or exercise a private property in the fishery, as was the case on some parts of the shores of Scotland. These *public* fisheries were abused, manufactories arose on the rivers, obstructions were erected, close times were scarcely known, or if so, were neglected; and a spirit of retaliation gained on the fishing population, sometimes reaching to the extent of mutual little forays, subversive in turn of fixed nets and obnoxious mill-weirs. These annoyances now and then, as in Rebecca's district, took even a more aggravated form, and seriously endangered property; and landed proprietors, anxious to see the law not altogether set at naught, with the sanction of the Government, got act after act passed, directed chiefly

at some glaring abuse which at the time had called forth their energies, but mostly inefficient and unworkable as general measures. On the other hand, speculations thought to be more profitable than salmon-fishing gained the attention of other proprietors; and they, under the shelter of their private rights, overlooked those of the public, and set up erections fatal alike to the continuance of salmon, or to the share their neighbours higher up the river should receive. Altogether the case seemed hopeless. The public in the estuary, the millowners, miners, and population above it, seemed to take the matter into their own hands; every feeling of parties was antagonistic; there was no co-operation; and the proprietors who really did take an interest in the fisheries were disgusted, gave up interfering with the abuses, and preferred seeking their sport at a distance to losing their money and tempers at home.

Now, these fisheries being in the position above stated, another question suggests itself, What was the need of appointing the recent Government commission of inquiry, when so little had arisen out of the many previous inquiries, and the blue books consequent upon them? About the beginning of the century, field and river sports were in a great measure confined to the landed proprietors. The sale of game was not legal; permission for a day's shooting or fishing was a matter of great favour, and could sometimes only be obtained by considerable interest. The renting of a shooting or fishing was nearly unknown, and game or salmon were presents of the highest class; while from the want of rapid carriage, salmon could with difficulty be transported far in any quantity, during its best season, in a state fit for the table or market. Steamers commenced the change, Railroads completed it. Fisheries and good angling, hitherto scarcely known except in their own vicinity, were brought to light. Previously there had been abundance for the local supply, and at a low price. But the supply now vanished, except on the payment of a very high retaining fee; and the recollection of the former abundance and present scarcity of good fish enhanced the relish, and inquiry among the inhabitants as to the cause of the change has become general. The class of sportsmen has also changed. Commerce turned

out princely fortunes; pursuits not before thought of, at first attracting but a few, soon spread among men of all trades and professions, and shooting and fishing became the coveted recreations. Many ludicrous occurrences took place at first, and the class was laughed at. How could it be otherwise? A gentleman restricted during his previous life to a narrow sphere, through fancy plates and descriptions, was led to adopt certain ideas in reference to sporting and the costume requisite for it. His outfit for the field or flood was furnished by the most refined city professor, and contained everything except the useful. His ideas of what he was to do came from the same sources, and his discomfitures were numerous. Reality and practice soon overcame these, and our commercial chiefs became good sportsmen. They took and liked their recreation; and how could they better spend part of their honourably and honestly earned gains than in recruiting their own health and that of their families? What better recreation than that afforded in the pure air of distant sporting lands? Moors and rivers are now everywhere let; and railroads carry the sportsman and his tackle, his servants, commissariat, champagne and ice, from the crowded city whithersoever he will. The anglers return again to business; their doings serve for the winter's after-dinner converse; they are listened to by aspiring beginners; fish of all sizes are dreamt of; and troops of sporting spirits are begotten, precocious as parrs, ready to start next spring on their first excursion.

At this time attention in England was frequently directed to the value of the Scotch fisheries. Several committees of inquiry had been carried through, and attempts were made to increase the produce of the fisheries by artificial breeding. The discussions on the natural history of the young salmon or parr, the breeding ponds of Drumlanrig and Stormontfield, all tended to keep the subject before the public in its most attractive form. The salmon fisheries in Ireland began to show decided improvement under a Government supervision; while the *Field*, the country gentleman's newspaper, kept the fisheries constantly in its columns, and enlisted anglers of all classes in the cause. In short, angling became fashionable, the public at large got the catchword, and those really interested

took the opportunity to call for an inquiry. It was full time for this. The check has been given before it is too late; for had a wholesale destruction such as we had clear evidence of, or witnessed, continued at all seasons of the year, the utter extirpation of salmon must by-and-by have taken place. But this very abuse and destruction makes the case more hopeful; for with proper and suitable regulations it will not be difficult to restore the rivers which have maintained a produce under such disadvantages.

Severn.

The Severn has been celebrated for the early condition and fine quality of its salmon, and notwithstanding the rude fixed engines by which its estuary has been long very extensively fished, it once possessed every requisite for a first-class salmon river.

If we regard the Bristol Channel, between Bull's Point near Ilfracombe, and Portymon's Point on the opposite coast of South Wales, as a salmon fishery, there is no tidal opening or firth to be compared with it (except that of the Solway) within a line drawn between Kirkcudbright on the Scotch side and Whitehaven or St Bees' Head on the English shore. The Solway is considerably less both in its water drainage and in the length of the river-courses flowing into it, but both firths possess several points in common. Several large and important rivers discharge themselves through their estuaries into them; intermediate among these are rivers of lesser size, which salmon and sea trout also ascend regularly, while many still smaller streams flow from every valley and glen, up which, at a later period of the year, the migratory fish also run, but do not continue longer than to deposit their spawn. These latter water-courses, though far from unimportant, can only be looked upon as *breeding-grounds*, not as *fishing-grounds* where a supply of salmon throughout the season could be regularly obtained, or where angling throughout the year could be pursued with any certainty of sport. The great mass of salmon and trout that are bred in these various streams enter the firth or channel in common; and although

many of them seek and may find the rivers of their birth, those which are bred in the smaller streams mingle with the others, and swell the spring and summer produce of the larger rivers. It is quite clear, then, that any channels or firths having the natural characters we have now mentioned, must be legislated for as a whole, and that any Act of Parliament framed for such waters must be founded upon uniform enactments, arrangements, and regulations.

The Bristol Channel, between the Taff on the Welsh side and the Axe on the Somersetshire coast, receives a large mixture of fresh water on the north side,—a drainage or water-shed from no less than 8580* square miles is discharged into it from the Severn, Wye, Usk, Avon, and other smaller streams,—and this influence is without doubt felt by the fish which hover about its mouth. It is in the tidal estuary of the Severn below Gloucester that the principal salmon fishery is now conducted by fixed engines. One of the best localities to examine these is at Gatcomb, on the southern side. This is easily accessible by rail from Gloucester, and the station is situated close to the water's edge, with putcher stages within a few hundred yards distance. All the modes of fishing now employed can be examined here; and there is much, besides, to interest both the geologist and botanist.

Lade Nets.—Lade nets are bag nets on a frame attached to a long handle. They are pushed before the fisherman, and are employed chiefly for taking shrimps; but they are also particularly constructed and used for catching up the salmon frequently left in the pools and “lades,” which remain at the receding of the tide and at low water.

Stop Nets are fished from a boat. These are more extensively used in the Wye and Usk, &c., and will be noticed when we mention these rivers.

Putts and *Putchers*, or *Trumpets*, as the latter are termed from their shape, are the special engines used in the estuary of the Severn for taking salmon; and they form there by far the most extensive salmon fishery, by means of fixed engines, in any part of the English or Welsh waters. These machines have been employed as far back as can be remembered, and

* Peterman's Hydrographical Map of the British Isles.

are first taken notice of in the Act of Elizabeth (I. chap. 17, 1558), as butts, among other engines for which regulations were made,—“*Net, Weele, Butt.*” They are, in fact, engines of the most primitive construction, rude almost in the extreme; and we can scarcely suppose the fishery of a river so valuable as that of the Severn to have been conducted so long without change or improvement.

Putchers or trumpets are long, conical, wicker-work baskets, with a mouth of two feet wide, gradually narrowing and ending in an opening so small as to prevent a fish of moderate size passing through. This, indeed, is frequently abused, and some are made so small as to take fish of two pounds weight. The stake or framework for these engines is about thirteen or fourteen feet high, and is fixed into the shore in two parallel rows of various length, from high-water mark seaward. These are bound together by cross-bars, on which rest the *putchers*, placed one above another in rows, with the wide mouth up or down stream, as they are intended to catch fish upon the ebb or flow of the tide. The greatest number are set with the mouth up the river or to the stream; the salmon falling down with the current enter the large mouth, and are literally jammed in the narrow end, which admits the head only, and holds the fish secure. The fish are thus often much injured, and rendered unseemly for the market by the scales being rubbed off in the struggles to escape, and no unclean, unseasonable, or old fish that enters can again escape or be let out alive.* The tide in the Severn rises to a great perpendicular height, often exceeding twenty feet above the top of the putcher stages;† and it is considered that comparatively few salmon are taken during the flow, the fish swimming near the surface and above the mouths of the putchers as soon as the tide rises a few feet above them. Most fish are taken in the ebb, or in the putchers with their mouths set up the river, proving without doubt that a large number of fish ascend so far, and return again, without ever entering the fresh-water part of the river; but whether it is that salmon in a certain

* Minutes of Evidence, 1861. Mr. Thos. Sargent, 1482, 1492.

† At Oldburgh the rise above low water is thirty-three feet.—Min. of Evid. 1861. Mr Joseph Robinson, No. 713.

condition hover about the estuary from day to day or from week to week until they find it agreeable to ascend, or merely that those return the hindmost of the shoal which only reach a certain way before the ebb commences, and do not feel the influence of the fresh water sufficiently to carry them on, is not yet distinctly made out.

The *putts*, or putt-nets, as they are sometimes called, are placed on the same kind of stages. They are also formed of wicker or basket work, but are more complicated, and the wicker-work is closer, and executed with more care. The whole machine is about twelve feet long, and consists of three parts, which can be attached to each other as occasion requires: the kipe, butt, fore-wheel or biddle. The diameter of the chief part, or kipe, is about five feet at the mouth, and fourteen inches at the lower or narrow end. The butt is fourteen inches wide at the neck and six at the lower end. These take large fish by having cross-bars placed in the narrow end; and to this can be affixed at will the third part, the *fore-wheel* or *biddle*, constructed somewhat like a mouse-trap inside, and used for taking everything small—shrimps, small soles, young cod, flounders, eels, lamperns, &c., &c. In one taken off a few days before, we found shrimps, a small eel, and a rock pipit,—in fact, nothing that enters the large, open, five-feet-wide mouth escapes when this fore-wheel is kept attached. The putt-net is extremely destructive to all young fish, and in spring, when the salmon fry descend, they are taken in hundreds.* The fishermen, however, say that they now remove the fore-wheel during the fry season, and it is the river conservator's duty to see that this is attended to.

In 1825, and previously, it would appear from the evidence taken before the committee on the salmon fisheries of the United Kingdom, that these putts and putchers were erected and allowed to remain in fishing order during the whole year, and that the removal would have been too expensive; and thus far improvement has been made, that they are now removed during fence months. By a report on the Severn and Teign

* "Is that fixed machinery very destructive to the fry? Uncommonly; that has been a great source of destruction. They take millions in a night."—Mr Evan Provert, Rep. Sal. Fish. Un. King. 1825, p. 6.

salmon fisheries, July 1843, we are informed that these engines have been much increased in number. At present in the estuary of the Severn there are from 80 to 100 putt and putcher-stages employed; many of them have "stanks" and brush or wicker-work "hedges," so as to guide or drive the salmon on to the front or fishing face of the stage. These stages employ from 50 to 500 putchers on each, and some fishermen possess above 1000. Altogether, from their number and contiguity along the shores, they are a formidable obstruction in the run of the salmon. They are specially objectionable to the proprietor or fishermen, as being precarious and uncertain in their mode of operation, two salmon out of two hundred putchers being considered a fair average take in the tide; as injuring the fish for the market by their mode of catching;—and to the public fisheries by the impossibility of releasing old or unseasonable fish, which, when they have once entered the open mouth, cannot be taken out unhurt. They are very destructive to young fish of all kinds when the fore-wheel is attached, and it would be impracticable to put them out of fishing order so as to observe a weekly fence or close time.

It may be asked, If these engines were removed, how would salmon be procured for the public supply? At present various parts of the estuary are fished with draught nets; and although some of the localities where a putcher stage is erected may not be suitable for landing a draught net, they might be employed in many other places, and the use of nets with a larger mesh would remove the objection of the strength of the current, so much urged against their practicability. What are called "fleet nets" might also be worked, and in addition we should have the tidal waters above to assist the supply. But this would be unjust, say the putchers; you force us to pass a number of fish which we have a right to, or to which a right has been taken. The injustice is all on the other side, for the monopoly of the lower waters has gradually crept on. The recent erection of weirs and the increase of the fixed engines have made it nearly complete, and at the same time the fishery of the whole river has been most seriously injured.

The tidal waters of the Severn above Gloucester are either

held by special grants, and are fished or let by the proprietors; or (as in most cases) they are free to the public, and a small annual rent is paid, sometimes in fish, to the owners of the adjoining lands for the convenience of landing the nets, or for a "fish house" and other accommodation.* Certain men or families who have sufficient capital join and fish, three men being required to each net, and they arrange among themselves taking the draughts at the different fishing stations alternately.† Above Worcester there are very few nets, at Worcester six or seven, and between Worcester and Gloucester about twenty. Several nets are in use, which employ about sixty men. These salmon nets, fairly fished, are not injurious; but other nets are in use, and nets of almost every description, form, and size of mesh, may be seen drying on the island below the bridge at Tewksbury; and when a small mesh is used in spring, taking the salmon fry cannot be avoided.

The greatest injury to the Severn in the tidal part of its course is caused by the large navigation weirs erected very lately under Act of Parliament, and sanctioned by the Admiralty. By the evidence of Mr Griffiths, who resided at Gloucester, and should have been well acquainted with the river, there were no weirs or obstructions in 1825.‡ Mr Griffiths, when asked if there were no weirs on the Severn, replies, "I am not aware of any upon the Severn; so far as my knowledge extends, there is no weir whatever." And although by the Severn Navigation Act salmon were recognised, for it was declared that there shall be openings "sufficient to pass the fish," this vague provision was not acted upon, and the proprietors of the land adjoining and the public looked on during the erection of the weirs, and either dared not or did not think it their business to interfere with the operations in progress. Only a few years since, a new cut or channel for the Severn was made below Tewksbury, upon which a very formidable weir was erected. It is a complete barrier to this great river; and what fish do get up force their way, and struggle through the locks.

* Min. of Evid., 1861. Mr Charles Reed, No. 413.

† Ibid., Nos. 418, 423.

‡ Rep. Sal. Fish. U. K., 1825, p. 9.

There can be no doubt that the salmon fishery of the Severn has decreased, though sixty or seventy years since there were fewer fishermen engaged, and the take by individuals was much larger than it now appears, scattered over numbers. We learned from some old books kept by the ancestors of Mr William Viner Ellis, that in 1792 (which was a remarkable year), in one week, from 29th January to 5th February, in four fisheries, 292 new fish were taken weighing 4583 lbs., or an average of $15\frac{1}{2}$ lbs. each; many would be of greater weight, but the size of these fish tells more for the Severn at that period than even the quantity. In the lower waters and estuary of the Severn, which we have been considering, salmon are the principal element of value in the fishery. The local name "sea trout" is used; but the river being closed, we did not identify it as *S. trutta* or *eriox*. It is a scarce fish, and runs rather late. Common or brown trout at present forms no element in the rental of the lower Severn, although it is scarcely fair to overlook the subscription drawn by the Association, which is chiefly paid for the right of angling trout. These are taken of good size and quality, many of $1\frac{1}{2}$ lb. and 2 lbs. weight; and at Beverley Weir, which seems a favourite locality, trout 4 lbs., 8 lbs., and as high as $10\frac{1}{2}$ lbs., have lately been taken. The shad is a more important element, the fishery for which takes place about the end of March and in April. The value amounts to a third of the whole, and sometimes even the fishermen depend on the shad and twaite for their rent.* Seventy or eighty dozen per net are sometimes caught in a night,—more than a ton weight; cart-loads are brought into the city of Gloucester in a morning, and people called Scudders wait for them on the banks, and sell them in the neighbouring county and towns. Flounders, eels, lampreys, and lamperns also assist. The lamprey is not so much sought after as it used to be. "The lamprey eaters seem all dead," says Mr Viner Ellis. Shad spawn on different fords below Worcester.

In the upper waters of the Severn the effects of the weirs have also been severely felt, for all the fish mentioned being

* Min. of Evid., 1861. Mr Charles Reed, No. 508. Mr Sam. Long, No. 828.

migratory, or seeking the fresh waters for the purpose of spawning, formerly ascended as far as Shrewsbury. Salmon are still enabled to struggle through, running the gauntlet over weirs, through sluices, locks, and slaughters, and some reach Lord Powis's weir, or Pool Quay, near Welshpool, one hundred miles above the tideway; but the large navigation weirs have effectually shut out shad, flounders, and the smaller migratory fish from all the higher parts.*

Lord Powis's weir is at Pool Quay, nearly one hundred miles above the tide, and flounders, shad, &c., as already stated, have been known as high as this barrier. This weir supplies water for gypsum and grain mills, is placed quite across the river, and is inaccessible except in extreme floods. We saw this at half-flood, with a very large body of water flowing over. Various salmon attempted it while we stood by, but not one could either leap it or stem the long run of the slope; and even if they could have done so, and reached the top, a projecting tree or log of wood, along the whole ridge, would almost certainly turn them back. Lord Powis has a fish trap at one side, and we were assured by a person who afterwards joined us, that this was never fished except for his Lordship's private use. When we came up to the weir, the trap had the water running through it, and could have been put in fishing order in five minutes. It was now close time. We do not say any one made use of it, but Lord Powis had placed there a strong temptation, when there was a good many salmon below the weir, and all the fishing gear in their places. The opening or shutting of a sluice made the whole difference. The night before we saw this weir, the river had been extremely high, running almost smooth over the top. We do not think salmon run freely in these extreme floods; and if they did, this flood was an exception seldom occurring. Lord Powis's weir cannot be overcome; and his trap, when not *fishing*, and in close time,

* Mr Edward Hughes states, "Plenty of shad came up before the erection of the navigation weirs, and brought from 8d. to 1s. per lb.; and a fisherman would take as much in a night as 20 or 30 lbs. of flounders, worth about 6d. or 8d. per lb. Lampreys are entirely gone,—we see nothing of them."—Min. of Evid., 1861; No. 8413, *et seq.* Flounders were taken as high up as Lord Powis's weir.

is *shut*, and thereby closes the only narrow access to all the river above. It is computed that forty miles of good spawning ground are barred out by this.

Such is the simple story of the Severn. The finest river in England is nearly ruined by building walls across it, sufficient to stop everything except a large and powerful animal, whose instinctive energy to continue its race forces it through everything that will admit its body. Yet, notwithstanding, there is no river affords more hope than the Severn, were its restoration properly taken up. The whole character of the river and its tributaries is favourable,—a large body of water, deep pools, and abundance of spawning ground exist, and there is yet no pollution from mines. We have already mentioned the quantity of large salmon taken in former days at the beginning of February in the lower part of the river, and Mr Shaw told us that one year he knew thirty-three large salmon taken in the month of January above Shrewsbury. Looking at the large size of the salmon mentioned, and some of them having been taken so far up, the Severn would become a most valuable river at the early part of the season, could anything like an easy passage be given to the fish.

Grilse are now very scarce, which is accounted for by its being impossible for them to surmount the high navigation weirs at a season when the supply of water is generally low. A great variety of other fish are abundant in the Severn. Grayling, perch, gudgeon, ruff, and all the ordinary Cyprinidæ, —these formed a great assistance to the food of the humbler classes, and unless very great abuse occurred, such as killing the fish by poisoning, or such-like, there would be an ample supply for all. Flounders, eels, shad, &c., were seen to have been formerly abundant; these yielded revenue to the fishermen; but we do not see that they can now be carried over the navigation weirs, or ever restored to their previous numbers.

During our examination of the Severn, some circumstances were brought to our notice which are of considerable importance, and are worthy of attention. The emptying of gas works was generally much complained of; but an examination into the circumstances led us to believe that the ordinary refuse, except in extreme abundance, or in very dry weather

and a low state of water, was not actually fatal to the fish. The oily-looking matter floating on the surface would spoil the sport of the angler. But the ammoniacal liquor, or the clearing out of a gasometer, is fatal, especially in very low water. As the tar from gas works is of some value, and the ammoniacal liquor can in the larger establishments be made very profitable by the manufacture of sulphate of ammonia,—and some of these are ready to purchase that liquor from smaller establishments, which cannot afford to erect the necessary apparatus for themselves,—there is no necessity for allowing any portion of the refuse to escape. This is one of those cases in which the law should be enforced, and conservators should be directed to look very narrowly, and to compel the companies to make money of their refuse, and so assist their shareholders.* That a flavour (which comes strongly out when cooked) can be imparted to fish by the mixture of substances with the water, was fully made out by the evidence given on several rivers; and it seems more easily imparted than at first imagined. Such may be the case when we hear it said that salmon or trout has a “muddy flavour,” &c. It was proved that salmon in the Severn had “tasted of tar.” The flavour was brought out on being cooked, to such a degree that the fishmonger took back the fish, and gave others instead; he “tasted the tar himself throughout the fish from head to tail;” and the salmon, before being sent away, had every appearance of being perfectly good. This circumstance happened during the year that some creosote works were working and discharging refuse into the river. The same fishmonger had two lampreys returned to him that tasted strongly of tar, but this he attributed to their being placed in a newly tarred boat, and sucking on to the sides with their mouth. At one time a boat laden with tar in casks had been sunk, and the casks were broken or burst while endeavouring to raise them up. White fish, flounders, &c., taken round this tasted of

* Mr De Vitre, chairman of the gas committee of Lancaster, states, “The ammoniacal liquor is a profitable part of the business; it pays very well for manufacturing it, and it obviates the necessity of getting rid of it elsewhere.” “We should be glad to take any quantity of ammoniacal liquor to aid our operations in making sulphate of ammonia.” — Min. of Evid., 1861, Nos. 9468. 9477.

tar when cooked. Creosote works, and discharge from them, or the escape of the "pickle," as it is termed, from the casks, also produce this taste, and kill fish; for in the River Parrett we found a similar complaint, and both salmon, eels, and flukes tasted of tar when boiled.

In the Severn and in various other rivers it was stated that the gudgeon, roach, and dace, &c., fed upon the salmon spawn, and their destruction or curtailment was often insisted upon as essential to the restoration of the rivers. This could not be brought to any test; no one had seen these fish taking the spawn, or had ever found it in their stomach. Gudgeon take minnow "savagely," and therefore the salmon fry were the most tangible and logical evidence of the fact we could procure. Nevertheless this is worth investigating. None of the fish mentioned can take up the roe from the spawning-beds; and any that may be caught when the salmon are in the act of depositing it, is unimpregnated and useless; but it is possible, in rivers abounding with the Cyprinidæ, &c., that they may know of and watch the spawning-beds when the ova are in the act of development, and seize the young as they come to the surface of the gravel, or while they are still helpless. It is worth while to ascertain whether such is the habit of any of what are termed "coarse" fish. Not by any means that we advocate their destruction for so doing. Some people advocate the killing of common trout, because they will take salmon fry; on the same principle may be advocated the killing of all the old salmon, because no bait is more successful for them than a small samlet. All the pike should be killed, says one,—all the eels, says another. We had a note a short while since, declaring war upon all seals and porpoises, &c. Now, if you kill all the trout, you leave myriads of aquatic larvæ which trout prey greedily upon. These larvæ are carnivorous, and are known to feed on the ova of fishes; kill all the pike and eels, and you will have the Cyprinidæ more than ever abundant; kill all the Cyprinidæ, and you leave nothing for the pike but young trout and salmon fry; kill both pike and coarse fish, and you force salmon to become cannibals and feed on their own offspring. If you make war upon the seals and porpoises, what curtails

the shoals of hake, &c., that crowd the mouths of the estuaries, and take a large proportion of the young fish as they leave the river? Man loses sight of himself as the *great destroyer*, and in his ignorance tries to interfere with God's own arrangements among His creatures, and with the beautiful balance everywhere established.

All animals have their parasites; these, when in excess, whether from any particular state or condition of the animal, or other cause, are then injurious, and even cause death. Among fishes parasites are very common, both external and internal; and among the migratory species one series is found upon them while in the sea, which is supplanted by others on their entering the fresh waters. In a few cases vegetable or fungoid growths appear, which was specially the case in 1859, when the pools became stagnant and heated, and the water very low. It attracted the attention of the fishermen, and it was also observed that the small fish, kept in tanks for bait, were at the same time attacked with it. When endeavouring to elicit the causes for the diminution of the different kinds of fish in the Severn at Shrewsbury, and where all were anxious to give as much information as they could, two circumstances were mentioned that were thought to have assisted particularly in the diminution of the grayling, which Mr Shaw stated had of late been considerable. It was stated that some small parasitic animals attacked salmon, trout, grayling, and other fish. They stuck to them, as many as twelve, twenty, or even forty.* These could be scraped off the fish when caught, "and when put into a pan they fight until they kill each other." Four or five years since these were very abundant, and last year (1860) they had again occurred in considerable numbers. Unfortunately, we have hitherto been unable to procure specimens of these parasites.

The Wye.

The River Wye, &c.—Our first sight of the Wye was at Monmouth, a town of ancient record, though not famed for its architecture, and perhaps not the best point at which to in-

* "It was something like lice upon salmon, and stuck to the outside of the fish and ate holes in it."—Min. of Evid., Mr H. Shaw, No. 8648.

roduce a stranger for the first time ; but to see salmon, not scenery, was our object. The time for tourists had nearly gone by, and the old bridge was more than usually crowded with lagging boatmen anxious to be hired to fish, or visit Tintern or Chepstow, as best suited time and inclination. Below, boats and barges, of manifold kind and form, were ready to convey parties of two or twenty whithersoever they wished, and in mid-stream plied four or five coracles taking "skirling."

The influence of the tide is felt nearly as high up as Monmouth, by the damming back of the water, and between that town and the sea there are no fixed engines or artificial obstructions whatever. The greater portion of this lower part of the river, extending about twenty miles in length,* belongs to His Grace the Duke of Beaufort, who appears to draw only about L.120 yearly from it ; and when we look at this long stretch of a noble river, and contrast the Duke's rental with those drawn from the Tay, Spey, and some other Scotch rivers, we naturally ask what is the cause for this difference ? It forcibly struck Her Majesty's Commissioners, that until the north of England and the Border are reached, none of the English or Welsh rivers produced a rental of any magnitude. There is nothing like L.4000 or L.5000, or L.10,000 or L.12,000 a-year ever drawn from any salmon river there, and there were, and in some parts there still are, large quantities of fish. The proprietors or their agents do not seem to understand the salmon fishery question, nor to have looked upon their rivers as capable of producing any considerable income. The weirs and fishing traps are let at almost nominal rents. But somebody, even in the reduced state of the fisheries, must be benefited, and it is possible that in several cases the proprietors are humbugged and plundered, and the public property and interest at the same time severely injured. Ignorance and inattention to the subject on the part of principal and factor, jealousy between upper and lower proprietors, and consequent want of co-operation, which in time beget illegal fishing by every means, are undoubtedly, on the Wye, the prominent causes of deterioration and exhaustion.

A stranger, accustomed to the clear streams of the North,

* Min. of Evid., 1861. Mr Wyatt, No. 930.

who visits the Wye at Monmouth for the first time, is struck with the colour of the water and the mud held in solution; and he thinks this the more remarkable, as the river rises in a high and mountainous district. The water is of a muddy green colour, and the shallow parts are much filled with large patches of weed, often of extraordinary length, and appearing very conspicuous from the bright red colour of the stems. Having heard much of its over-fishing, we were anxious to see its capabilities, and resolved to journey between Monmouth to Chepstow by water. The night had been rather rainy, and the boatmen said a "little fresh was on," which contributed to the increased muddiness of the stream. Frequent rises indicated the presence of the "skirling;" and in the beautiful looking pool above the railway bridge, a perfect specimen of an old Wye fisherman was seated in his coracle, his rod over one side, and his line in hand with ten or twelve hooks baited with maggots. This he was just about to let loose, and so to ply his daily trade of killing young salmon for his livelihood. Down we proceeded through grateful, pleasing, quiet scenery, through many a stream and pool, which would tempt the most apathetic angler, but in which we were again and again informed it was needless for him to ply his art. Salmon are said not to be taken now in these waters with any fly or bait; but what the reason is, without trial or experience we can scarcely say, unless that the fish are disturbed by the constant boating and coracle net-fishing, and do not get settled. Many of the places for "bush-beating" were pointed out; and now and then some fisherman stood perched upon a sod watching his float, as if on it depended his breakfast, standing as silent and motionless as a heron upon her watch. Down we rowed, without much change of character, until below Tintern Abbey, where the river becomes more muddy, the thickness increasing as we proceeded, until the water becomes really thick, impenetrable to any eye. The passage down is made pleasantly and conveniently, especially if the party are numerous and the luggage considerable. The expense is L.1.

The Wye, Usk, and rivers running into the northern side of the Bristol Channel, are peculiar, somewhat resemble each

other, and nearly the same modes of fishing are practised in them. The Wye is a large and noble stream, and possesses every requisite for a salmon river; like the Severn the tide has a very high perpendicular rise, and flows up nearly to Monmouth, but the tidal portion scarcely anywhere assumes the character of an estuary; it is narrow, above Chepstow becoming almost a gorge bounded on each side with limestone cliffs. This is filled periodically with a deep muddy tidal stream, which at low water leaves steep sludgy banks, in many places unfit, or at least inconvenient, for using a draught net or seine. The muddy water here renders nets of different kinds temporarily fixed during a part of the ebb or flow of the tide efficient, and it is by means of these that the salmon fishing in the lower part of the Wye is almost entirely managed. The ancient mode of fishing by coracles is much in use; but this is not confined to the tidal waters only, and it is more extensively practised in other rivers to be mentioned afterwards. The most productive mode of fishing, and that which is carried on to the greatest extent here and in the Usk, &c., is called "stopping," or "stop-net fishing," in other parts "compass nets;" it is, in fact, the peculiar mode practised in this system of rivers, and is almost confined to them.

At the commencement of the ebb or flow of the tide, a large boat is moored by anchor, and fixed by long sharpened iron-shod poles in what is supposed, or rather by experience is known to be, the "run of the fish." A large bag net, on a frame of from 25 to 35 feet beam, capable of being easily raised by the fisherman, is let out upon the side next the ebb or flow, so that the bag is carried out by the tide underneath the boat. The fisherman with one arm leans on the angle of the frame ready to act, and has the loop of a cord attached to the bag of the net round a finger of the other hand. The slightest interference with the net is felt by the looped finger, and when a salmon strikes, the net is quickly raised and the fish secured in the bag. At suitable states of the tide numerous boats may be seen going out prepared to "stop," and ply their precarious fishing. The stations are taken up by turns, some being considered more certain than others, to allow the men an equal chance. These fishings are generally sub-let,

the lessee of the fishery sometimes supplying boats and nets, and paying the men according to the quantity of fish taken, or a certain agreed-upon proportion of the price. It is a mode of fishing, however, far behind the present time and invention, and the boats and nets necessary for it must require very considerable capital. It is, moreover, uncertain, and occupies a large portion of time compared with the quantity of fish taken. There is nothing particularly injurious to the fisheries in the use of these engines if fairly employed, and any unseasonable or old fish may be easily set at liberty uninjured. At the same time several boats are sometimes set in line, and then they form greater barriers to a clear run ; but as it is only for a few hours at the flow of the tide, or after it has partially ebbed, that this kind of fishing can be practised, it can scarcely be looked upon as a serious obstruction. At Chepstow we were initiated into all the mysteries of this fishery by the attention of Mr Sargent, who is the lessee ; besides his evidence taken publicly, he gave us privately every information in his power. We saw and went on board the stopping boats, and had the good fortune to see a nineteen-pound fish captured by one of them. Mr Sargent holds his fishing on lease from the Duke of Beaufort. The general mode of letting is to tacksmen from year to year, but in some cases, as in that of Mr Sargent, leases from five to seven years are granted. These leases, drawn by the Duke's agents, contain very stringent conditions for preservation of the fish, and against breaches of Fishing Acts ; but still no attention seems to be properly given to see that these are observed, and they as well as the Acts of Parliament are unheeded. The great abuse here, and especially about Monmouth and Ross, is that of killing in spring the young fry, called here "pinks," on their way to the sea, and at other seasons the "skirlings" or "skerlings"—the *parr* of the Scotch rivers. This is done to an extent we had no idea of. Monmouth is the Woolwich of Wales, parties come from a distance to eat salmon pink. They are ordered for breakfast and dinner, and pink and skirling here hold the place of whitebait. Boats are hired by tourists for the express purpose of fishing these ; it is a trade and profession by which many of the boatmen and fishermen live and make their livelihood. Tradesmen and lads all

fish for them, and easily obtain a light meal; and regular traders hawk them about, call at private houses, and bring them to the hotels. When the "skulls" of fry are going down to the sea, the boatmen race after them, to have the first throw; and when they rise to the surface they are so numerous that they are taken by the hooks being drawn through among them. This is the regular employment of the coracle men, who all fish with ten or twelve hooks on one line baited with maggots, and so many as four hundred are known to have been killed in a day by one rod; and besides, in spring and early summer it is computed that not less than two hundred fishers go out daily, who may take, on a low calculation, from one dozen to twenty fish a-piece.

There is no doubt that these skirlings or skerlings of the Wye are identical with the much disputed parr of the rivers of Scotland. It is equally without doubt now, that these small fish, destroyed in such numbers, are the young state of the salmon; and it may be proper here to place the *parr question* in what we consider its right position,—more especially as we may have assisted in continuing the view still taken by some, that there DOES YET EXIST *a parr*, a veritable and independent fish, breeding and continuing its own race. We need not go very far back in its history; but since the different kinds of British fishes have been separately described and recorded, the parr has been regarded by authors either as a species, or a variety, or a young fish. It is described by Ray in the first book of Willoughby's "Ichthyology" as the *Salmulus*, "*Herfordiæ samlet dictus*;" and is afterwards noticed in the Synopsis of Fishes, where the distinctions between it and the common trout of the same size are pointed out. Pennant, who was well acquainted with the Wye and the Severn, describes it as the samlet, and expresses his dissent from those who hold it to be young salmon; and as some of his reasons, he states that "the samlets are found, male and female (distinguished by the milt and roe) of the common size," that they spawn in November and December, "at which time those of the Severn push up towards the head of that fair river, quitting the lesser brooks, and return

into them again when they have done."* Mr Pennant does not state the circumstances as from hearsay, but as facts. To this great Welsh author we are indebted for many valuable works relating to the natural history and antiquities of this country. He devoted a great deal of his time and talents to the study of these branches, and we ought therefore to be cautious in contradicting the two assertions quoted above. But in all our wanderings among lakes and rivers, and from all our inquiries, we have never seen, nor been able authentically to learn, that such states of the parr, under any circumstances, existed. In our recent tour of inspection of the rivers in England and Wales, we were frequently told of parr or skerlings having full-sized ova in them; but all offers, from half-a-crown to a sovereign, failed to produce them.

Difference of opinion on this subject existed up to 1834. In that year, accompanied by Mr Selby, James Wilson, and some other friends, all keen fishermen, we made an extensive tour through Sutherlandshire, attending to its natural history in nearly all its branches; and at the meeting of the British Association at Edinburgh in that year, a paper was read on the "*Salmonidæ met with during an Excursion to the North-west of Sutherlandshire*," which was afterwards published in this Journal, then so ably conducted by the late Professor Jameson.† The paper, with some additional remarks, was also printed in the "*Transactions of the Berwickshire Club*."‡ In these the parr is treated as a *distinct species*, its characters are pointed out, and it is stated that the part of its history "yet unknown" was its breeding. At the Edinburgh meeting, the fishes procured in Sutherland were exhibited, and specimens of parr and young trout from the Tweed, Annan, and other rivers, were also produced. M. Agassiz was present, Dr Fleming, Dr Parnell, and others. The ichthyologists of Section D were fairly puzzled, and the result of the discussions, I believe, was expressed in the following sentence, which has been quoted solately as the last year, for the purpose of supporting the view that there is a veritable *parr*. The sentence

* Pennant, Brit. Zool., edit. 1812, vol. iii. p. 405.

† Edinburgh Philosophical Journal, 1834, p. 46.

‡ Vol. i. p. 82.

alluded to is: "The difference of opinion among all our ichthyologists, or rather, the difficulty which they appear to have in forming one, whether this fish (the parr) is distinct, or only the young of some others, has rendered the solution of it interesting. The greatest uncertainty, however, latterly resolved itself into whether the *parr* was distinct, or a variety, or young of the common trout, *S. fario*. *With the migratory salmon it has no connection whatever.*" * The subject continued in this state, with various undulations, until 1836, when the experiments of Mr Shaw were detailed to the Royal Society of Edinburgh. The young dress of all animals varies from that of the adult; but the changes are more marked and decided in some groups than in others. Among some birds these are very remarkable; and many will yet recollect the controversial papers in the late George Montague's time, and those by Mr Selby and James Wilson, in regard to the changes put on by the Golden and Ring-tailed eagles, the Hen Harrier and Ring-tail, Gooseander and Dundiver, &c. These were settled beyond dispute by the birds being kept in confinement from the nest to maturity. This proof was not so easily obtained with fishes: procuring authentic ova or young was a serious difficulty, but Mr Shaw set himself to rear and keep the young of the salmon. He first procured young fish from the streams by means of a hoop-net, and afterwards he took the ova from a spawning-bed in which he had seen what he considered to be true salmon depositing their spawn; and having removed them to an undisturbed and suitable locality, he succeeded in hatching them, and bringing them forward to the time when the salmon fry began to take their departure to the sea. He produced parr in his ponds at Drumlanrig; but when exhibiting the specimens, of the genuineness of which in every respect he had no doubt, and in fact most of his hearers had none, he was met with the query, "How did you know that the small fish were the young of the salmon, or that the ova you took from the spawning-bed were deposited by salmon?" The flaw in the proof was evident, however well satisfied he might be that he was correct. The case was not proved in such a way as to refute previous

* Edin. Phil. Jour. 1834, p. 57.

opinions. These objections were obvious to Mr Shaw, and notwithstanding the time necessarily required, eighteen months or two years, he started at once to perform his experiments again in such a way as to remove all doubt of the identity of the parents. Mr Shaw captured two fish in the act of spawning—a male and female—at one cast of his hoop-net, took them on shore, artificially impregnated the ova, killed the parent fish, and produced the specimens, along with their young, at a future meeting of the Royal Society. This was unanswerable, and the young were without doubt parr. The experiments in the ponds at Stormontfield on the Tay have confirmed the same facts; and any one who will insist now that a parr is not a young salmon, must have some warp in his intellect, not to be removed by any possible demonstration. Mr Couch of Polperro, an intelligent naturalist, has last year written a paper “On the Natural History of the Parr,” and he still considers that fish to be distinct. He founds his opinion upon the circumstance, that in a basket of fish taken from a tributary of the River Fowey, in the month of January, “the examples (of parr) that measured six inches were severally supplied with milt and roe fully developed, and ready to be shed.” A figure was taken of the milt, but “accident prevented the roe from being dealt with in the same manner.” This is to be regretted, and also that specimens of the females were not preserved in spirits; for without doubting Mr Couch’s ability to distinguish, if the specimens do not exist, his statement is liable to the same query as Mr Shaw’s first experiments, Are you quite sure that these fish which you examined were parr, or the young of salmon? But allowing them to have been parr, Mr Shaw tells us that solitary instances have occurred of large female parr having been found in salmon rivers with the roe considerably developed; and when female smolts were detained in fresh water, until the end of the third winter, the individuals were found in comparatively mature condition.* The occasional appearance of a parr with fully developed roe is merely a proof that such sometimes takes place, and cannot affect the other fact, observed in innumerable instances, that the fish hatched from ova produced by salmon are parr.

* Trans. Royal Soc. of Edinburgh, vol. xiv. p. 564.

As we ascend the Wye, unfortunate destructive practices prevail, notwithstanding the interest shown by many parties, and the institution of the Wye and Lugg Association. At Hereford there is a fine reach of the river below the bridge, the fishing of which belongs to the bishop, who liberally lets it to assist the Association, and pays over the rent—L.10—as his subscription. A good view of this fishing pool is seen from the window of the little Museum, erected close to, and, indeed, overhanging the river. This building and room are very neat, but the Museum is, as usual, a confusion of a very little of everything, and in want of local productions; how interesting a collection of the river fish would be in their different states, and with the *local* names attached to the specimens! A fishmonger here invited us to see some salmon killed that morning (20th September), as specimens of fish in fine condition. The one was a large kipper, with hooked under jaw and bright red colour; the other a female full of spawn. These salmon would have spawned within the week. Our friend had a large shop, and was no second-hand dealer, and we could not but hold him ignorant of “condition,” or of the impropriety of encouraging the destruction of such fish, from the innocent manner in which we were invited to inspect them. Samlets here are also enjoyed by travellers and tourists, and are openly hawked about and sold to the hotels. Skerlings are taken by the peck, and so sold. They are taken from a boat with three rods, having seven or eight hooks on each line, which are dragged and re-dragged across the river. Even respectable persons in charge find an excuse; and a gentleman’s gamekeeper, when asked if he allowed gentlemen visiting to kill “last springs,” replied, he did not permit it—“only a dozen for Missus.” Higher up the river fly-fishing still continues a regular trade. One fisherman acknowledged killing 300 in one day, and did not consider himself paid if he caught less than 200. The selling price is 6d. per lb. This is called poaching by a great many persons and proprietors, but they have no right to do so—the proprietors who buy, or allow their housekeepers to do so, and the gentlemen who eat, are the poachers. So long as they create a demand there will be a supply, until the fish are extirpated; and it is ludicrous to hear a well-got-up land-

owner, possessed of a regular anti-poaching fever, inveighing against "poaching, and the blackguards that infest the river," while he himself cannot want samlets for breakfast. It might be well, in a new Act, that fine should be the punishment of taker and seller;—imprisonment, with or without hard labour, that of the buyer, if he owned a reach of river.

After leaving Hereford, the river begins to assume more of an angling character. Netting is more rarely practised from the nature of the river. In winter the usual modes of poaching are much followed, if it can be so called, for it is done openly, and by the farmers and their sons, who claim a sort of right to the fish that come up there. They are so taken to be salted, or otherwise cured, for the use of the family; but a spirit of retaliation for the fish being kept down during the open season, and nowhere allowed to ascend, also mingles in the desire for the unseasonable sport. In addition, the mining population at Rhyader, of Rebecca notoriety, gather in large bodies, and sweep the fords of the spawning fish. This has been done almost every year; and a short time after we had left Builth, one of these marauding parties had killed considerable numbers. On several of the tributaries this winter destruction is carried on to a great extent; in some of the smaller streams, it is asserted that "none return," and so sweeping is the destruction, that a "last spring" is scarcely to be seen. Notwithstanding all this, the reputation of the Wye is increasing, and higher rents are being given for its angling waters. Various clubs and associations have been formed, anxious to protect the river; but the co-operation of all parties is not cordial. By and by, when the advantages are known, we may hope for a better state of things.*

* At a meeting of the subscribers for the upper part of the Wye and its tributaries, held at Builth, this want of co-operation is seriously appealed to. The lower proprietors contribute a small proportion to the funds for preservation, and as they reap the first-fruits of improvement, from the care taken of the breeding-grounds, the upper proprietors feel this, and there is difficulty in getting them to continue their subscriptions. After the Report has enumerated various illegal modes of killing fish, it concludes, "One other species of destruction deserves notice, namely, that caused by otters, of which no less than sixteen have been destroyed by Mr Greenwood's keepers during the last three and a half years, and the committee trust that all gentlemen who have fisheries

In the Bristol Channel river system, the Usk is next in importance to the Wye, running a course of from seventy to eighty miles in length, and having a watershed supply-basin of 650 square miles. It has always been a celebrated salmon stream, almost more so than the Wye, and its properties are frequently noticed by the early poets. Churchhill says—

“Great store of fish is caught within this flood,
That doth indeed both town and country good.”

Fifty or sixty years ago, old women went about the streets of Newport hawking salmon cut into “gobbets,” and boiled, which they sold at 2d. the pound. In natural characters the Usk much resembles the Wye, and at Newport is a large muddy stream. This detracts much from river associations; and beautiful as the scenery is in many parts of these noble outlets, the muddy water breaks and mars it. Resembling the Wye, it is fished by similar engines, and has of late years somewhat recovered the great destruction and waste which was carried on in many parts. The usual modes of illegal fishing are carried on, and as the upper part of the stream runs through a dense mining population, there is a ready market there, whatever the condition of the fish may be. The farmers and their families also fish and spear in close time, and there is the feeling to kill all, “as they will not get back again.” From ten to twenty foul fish are frequently taken together by these family parties, which are used by the household. The mode of dressing is peculiar. The fish are cut up and put into a large pot, and boiled in milk. They are served up warm, and said to be much relished. If the mining operations towards the source do not increase, and become very deleterious, there is nothing to prevent the Usk being restored as a salmon river. There are no great weirs, as on the Severn. The Trosky weir, much complained of, was originally of “brush,” and now, even with amendments, is easily passed.

will assist in checking the increase of the animals.” Mr Greenwood’s keepers had better let the otters alone; if very numerous, there might be some reason for curtailing their numbers, but sixteen in three years and a half would point to the reverse. Otters do not live exclusively on fish, and in a stream where they are very numerous, we know of no injury done, and there is abundance of fish. The otter unfortunately comes under the head of keepers’ “vermin.”

Description of a New Species of Clerodendron from Old Calabar, which flowered in 1861, in the Royal Botanic Garden of Edinburgh. By JOHN HUTTON BALFOUR, A.M., M.D., F.R.S., Sec. R.S.E., F.L.S., Professor of Medicine and Botany.* (Plate II.)

The plant which I am about to describe was transmitted in a Wardian case to the Botanic Garden some time ago by the Rev. W. C. Thomson, one of the United Presbyterian missionaries at Old Calabar, on the west coast of Africa. It produced flowers in the hothouse in December 1861. The plant has a very showy appearance in the conservatory, twining along the roof of the house to the extent of ten or twelve feet, and giving off numerous clusters of flowers. The contrast of colour presented by its white calyx and crimson corolla render it a desirable plant for cultivation. Along with the plant, Mr Thomson sent a few notes and a rough pen-and-ink sketch of the flower. He also expressed an opinion that the plant was new, and if so, he wished it to be named after his late wife.

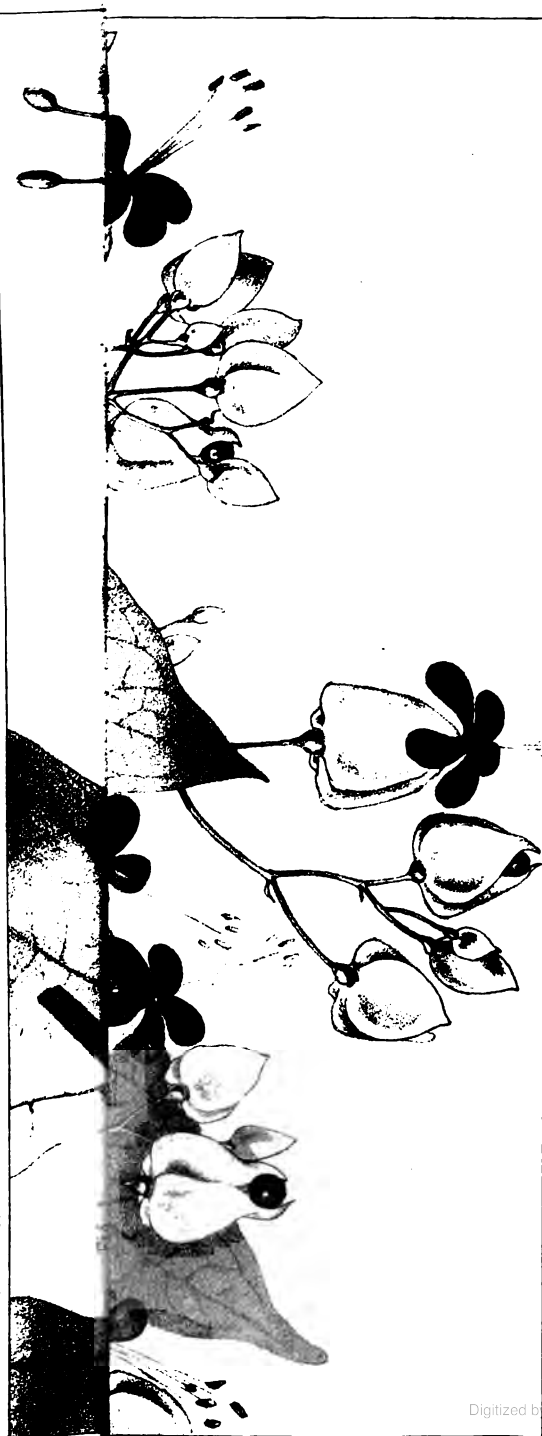
The plant belongs to the natural order *Verbenaceæ*, and appears to be an undescribed species of *Clerodendron*. I have therefore denominated it *Clerodendron Thomsonæ*.

Generic character.—CLERODENDRON† (L.)

Calyx campanulatus, rarius tubulosus, interdum pentagonus et subinflatus, 5-fidus vel 5-dentatus, rarissime truncatus. *Corolla* infundibularis vel subhypocraterimorpha; tubo sæpissime calycem conspicue excedente, interdum longissimo; *limbo* 5-partito, laciniis superioribus paulo magis approximatis, subinæquali, vel laciniis inferioribus magis minusve adscendentibus, obliquo, immo subsecundo. *Stamina* 4, corollæ tubo inserta, longe-exserta, subdidynama; *antheræ* supra basin insertæ, basi fissæ, biloculares, *loculis* parallelis, rima

* Read to the Botanical Society of Edinburgh, 9th January 1862.

† From *αλεξας*, lot or portion, and *δενδρον*, a tree. The name is given to the genus in allusion to the salutary or dangerous effects of the different species which constitute it. Thus *Clerodendron fortunatum* is useful in medicine, while *C. calamitosum* and *C. infortunatum* are the reverse.



W. H. H. Johnston, Lith. Edin.

CLERODENDRON THOMSONI BALFOUR.

longitudinali dehiscentibus. *Ovarium* 4-loculare, loculis 1-ovulatis; *ovulo* in spermophoro angulo centrali adnato, pendulo. *Stylus* filiformis, exsertus, stigmate bifido acuto. *Drupa* calyce ampliata insidens vel inclusa, baccata vel carnosâ, quadri- vel sæpius abortu mono-di-tri-pyrena, sæpius 2-4-loba, *pyrenis* maturitate distinctis unilocularibus, *putamine* lignoso lævi. *Semen* solitarium, erectum. *Cotyledones* oleosæ, applicitæ; *radicula* brevis, infera.—Frutices vel arbores inter tropicos veteris orbis, imprimis vero Asiæ, copiose, in America vero parce crescentes. Folia opposita vel terna, simplicia, integra vel rarius lobata, phyllopodio interdum prominenti persistenti insidentia. Cymæ trichotomæ vel axillares, vel in paniculam terminalem collectæ. Schauer.

I. EUCLERODENDRON.

Corolla hypocraterimorpha, tubo calycem subæquante vel majus minusque excedente (pollice vix unquam longiore) limbo patente vel subsecundo.

Specific Character.—CLERODENDRON THOMSONÆ (Mrs Thomson's Clerodendron).

Caule volubili glabro, foliis oppositis brevi-petiolatis integris oblongo-ovatis acutis glabris, venis superne sulcatis, panicula axillari et terminali, cymis dichotomis laxifloris bracteatis, calyce albo membranaceo inflato pentagono 5-partito laciniis ovatis acutis, corolla coccinea, tubo gracili extus glanduloso-pubescente calycem æquante, limbo obliquo 5-lobato, staminibus longissime exsertis.—Frutex volubilis crescit ad ripas fluminis *Old Calabar* in Africa occidentali.

A shrubby twining plant. Stem terete, of a light gray colour, bearing numerous lenticular warty excrescences on its surface; branches twining extensively round other plants or prostrate and rooting. Leaves dark green, mostly opposite, exstipulate, oblong-ovate, acute, entire, glabrous, margins slightly reflexed; reticulated in venation, midrib prominent below, two lateral ribs coming off from the base of the midrib, all the ribs and veins grooved on the upper side; largest leaves about nine inches long, and from three to three and a

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half inches broad. Petiole short, about one-fourth of the length of the lamina. Inflorescence chiefly axillary, cymose, dividing dichotomously, with two small linear bracts at the division of the cyme; flowers placed in a second manner on the stalks; peduncles and pedicels pubescent. Calyx gamosepalous, hypogynous, thin, flaccid, membranaceous, persistent, large and inflated below, narrowed above, of a pale whitish colour, with greenish veins here and there, extending a short way from its base, which is also greenish and is closely applied to the ovary, after the fall of the corolla assuming a dingy purple colour, æstivation reduplicate, five projecting angles at the union of the sepals, with depressions between the angles, divided about two-thirds down into five segments, which are ovate-acute and tipped with green. Corolla gamopetalous, with imbricate æstivation, at first completely enclosed within the large calyx (which is developed very early, and long before the corolla), afterwards the corolline limb extending beyond it; tube long, slender, equalling the calyx, covered with glandular hairs, pale-coloured, and slightly reddened at the upper part; limb of a fine crimson colour, presenting a remarkable contrast to the white calyx, irregular, of five short, unequal, oblong-ovate blunt segments, the lowermost being the longest, the two uppermost separated from each other by a marked notch, through which the stamens project. Stamens four, didynamous, much exserted, being twice the length of the corolla, in æstivation coiled up spirally and retrorsely; filaments pinkish below, pale above, inserted about the middle of the corolline tube; anthers grayish-yellow, two-lobed, introrse, attached above the base, dehiscence longitudinal. Ovary of four concrete carpels, with a central placenta, 2-4-celled, surrounded at the base by an annular disk; style apicilar, long, filiform, shorter than the stamens, but longer than the corolla, becoming finally slightly curved backwards; stigma bifid. Fruit* of two, three, or four achenes, with a fleshy, rugose, bright scarlet substance resembling a one-sided aril, which is developed after the fall of the style. Cotyledons epigeal.

* The characters of the fruit are taken from Mr Thomson's notes. The plant has not borne fruit in the Botanic Garden.

Mr Thomson states that the plant grows abundantly on the banks of the Old Calabar River above salt water range.

Description of Plate II.

Fig. 1. *Clerodendron Thomsonae* (Balf.). Showing its twining habit, oblong-ovate usually opposite leaves, short petioles, axillary panicles of cymose flowers with inflated calyx, oblique 5-lobed corolla, and exerted stamens. The figure does not show clearly the grooving of the ribs and veins on their upper surfaces.

Fig. 2. Calyx removed, and tube of corolla opened to show insertion of didynamous stamens, concrete ovary, apicilar filiform style, and bifid stigma.

On the Geological Age of the Pagan Monuments of the Outer Hebrides. By Capt. F. W. L. THOMAS, R.N.*

Some recent observations made upon the geological changes that have taken place since the so-called Druidical circles were erected in the Long Island, will, it is presumed, be interesting to the Society; although any conclusions from these observations can only be valued as first approximations to a knowledge of the era of the unknown founders of these gigantic monolithic structures.

It forms no part of the present subject to describe these monuments farther than to state, that, as in the Orkneys, in one locality of the Lewis several of these circles are placed within a short distance of each other; but no peculiarity is observable in the selection of their position; and, from all that is known at the present time, their place of site appears to be accidental, or at least chosen without any distinct motive. One of these circles, the far-famed stones of Callernish, occupies the flat of a ridge of hilly ground, while two others are near together on a wet and boggy moor, at the distance of a mile to the eastward of the first. If the circles situated on the moor had been visited two or three years ago, nothing but a few gray blocks even with, or protruding two or three feet above the bog, would have been seen, and even many of the stones of the large circle of Callernish were completely grown over and buried in peat. By the liberality of Sir J. Matheson these three circles have been excavated, and it was then found

* Read before the Royal Physical Society on Wednesday, 26th Feb., 1862.

that the peat had accumulated to the height of between five and six feet. From an attentive examination of the foundation of these circles, I arrive at the conclusion that the stones were pitched before the growth of peat had commenced, or at least at the very commencement of the peat-forming epoch. The upright stones are founded in the (so called) boulder-clay which overspreads this, with most other parts of Scotland, and the peat rises uniformly from the clay to the surface, which would not be the fact if holes had been dug in the peat to receive the stones. Besides, some stones that had early fallen (in the smaller circles) rest upon the clay without any peat below them; and still further, in two of these circles are loose heaps of stones,—“cairns,” as they are called, the grave-mounds of the illustrious dead,—which also rest upon the clay, without any intermediate floor of turf. If any peat had grown, it would be found beneath these cairns, for I consider it childish to suppose that it would have been cleared away. At the excavation of a tumulus at Stennes, in the Orkneys, which was presumed to be of or about the same age as the adjacent stone circles, the heath and moss on which the materials of the tumulus had been heaped were found in as good preservation as when the mound was made.

Besides the circles named, there are others, both in Lewis and Uist, which are only discovered by an occasional stone peering above the surface; and I see no reason to doubt that some of these Pagan monuments are entirely buried and out of sight.

I produce a stereoscopic photograph of the Callernish circle, which fortunately shows, by a difference in the depths of shade, the height to which the peat had grown around the stones; two of them, to the left hand, were entirely covered.

If, then, it is admitted that the stone circles of the Lewis were placed before, or only when the peat began to form, and that the peat has grown five feet since that time, it is evident that the least age of these monuments would be known if the annual increase of peat was known. But I am unacquainted with any data from which to form an estimate, and there is a wide difference in the opinions held on that point. One practical gentleman assured me that the Lewis peat grew an inch

every year; at this rate the entire deposit might have taken place in about sixty years. Another estimate is nine inches in a century, but we require twice the number of years that this ratio would give to get back to Pagan times. As I am unacquainted with any class of facts that bears upon the subject, it is not worth while to offer any conjecture at the present time. I may mention, however, that to my surprise, one of the Lewis bards has a tradition that at one time there was no peat in Lewis; and it is also to be noted, that almost always on excavating any of the Pictish dwellings pieces of burnt stick (charcoal) are found at the fire-hearth. I do not wish it to be inferred, however, that there was no peat to be then found—only that sticks formed part, if not all, of the fuel then in use. A most instructive section was made a few years ago on the banks of the Creed, in the policies around Stornoway Castle. My notes are mislaid, but if my memory is correct, a cutting was made through a peat-bank to form a road, by which a perpendicular section of between eight and nine feet in height was exposed. About the middle of the bank, that is, three or four feet below the surface, was and is the place where a fire had been kindled, a few stones had been put round on which to stand the kettle, probably to boil a salmon, and bits of charcoal still remain in the ashes. The banks of the Creed could still supply enough indigenous birch to boil a craggan.

Very erroneous opinions are abroad concerning the cause and growth of peat; in most books I see the observations of a certain Lord Cromarty are quoted, from which it is most illogically inferred that all peat is the result of the decay of forest trees. So wide spread is this allusion, that it has been quoted to me where the peat-banks were visibly and presently telling their own history. Without denying that the decay of forest trees in marshy ground will form peat, it requires only the most superficial observation to know that wood peat occurs only in the most homœopathic quantity in, at any rate, the islands of North Britain. It fortunately does occur as an exceptional instance, and then in so marked a manner as to leave no chance of confounding wood peat with the almost universal moor peat. The bulk of the peat of the northern and western islands is made up of the roots of rushes and

moor-grass; the mosses help to keep it constantly wet, and the tormentilla (and probably other plants) supplies tan to the moss, and prevents it from decomposing into vegetable earth. Such were the conditions when the peat first began to grow, and such they still continue. I have looked over thousands of sections of peat banks in which there was no difference in the composition of the peat, from the base where grew the first peat-forming plants to the surface at the present moment, excepting consolidation towards the bottom from time and pressure. When the surface of a peat bank has been exposed for some time to wind and rain, the most solid, as well as the spongier portions of the peat will be found disintegrating into laminæ, which laminæ probably represent the annual growth, and if they were distinct enough to be counted would indicate the age of the peat. From whatever cause, there was a time when the general surface of the country was bare and lifeless, which was followed by a growth of plants, in no way differing from those that are now struggling for existence upon the moor. And from what has been said before, it would seem that man made his advent here at much about the same geologic time.

A common tradition of the Lewis is, that the ground was once entirely covered with forest trees, and that the wood was burnt down by the Northmen to deprive the aborigines of the shelter that it afforded. In almost all traditions there is some relation to fact; but without going into the history of this opinion, it will be enough to notice, that as far as I am aware there is but one place in Lewis where the remains of forest trees are to be found. The roots of firs over twelve inches in diameter occur near Balaline, in the parish of Lochs, and only there. These roots are always on the clay soil, for neither bush nor tree is found with its roots in the peat.

But although in a thousand cases the section of a peat bank, from its surface to its base, exhibits only a succession of marsh plants, a patient observer will here and there find a spot where the foundation of the peat is a floor of twigs and leaves. This, as stated before, bears only a minute proportion to the moor peat of the country. When examined it appears to be made up in great part of the twigs of the birch, but I have no

doubt that the berry and bush of the mountain ash, the larch, the aspen, and the willow could be detected. In fact, it so happens that in this strange country, where many of the manners of the tenth century still exist, the method by which this peat of scrub and brushwood was formed can still be seen. On the small islets in the lakes, to which neither sheep nor cattle can gain access, a dense mass of scrub still survives. The heather will grow four feet in height, and above that may be seen the red berries of the mountain ash, or, if in spring, the catkins of the willow, or the pendant leaves of the aspen, with briars and brambles to interlace the whole. In the face of some cliffs and banks, and even in a few remote spots, the holly, hazel, aspen, birch, and willow, still struggle against an adverse climate as they did a thousand years ago.

I have been thus particular in pointing out the limited quantity of wood peat, and where it occurs, its position, resting upon the boulder clay, for a purpose to be more particularly described at the close of this paper; and I pass on to notice some important geological changes that have taken place in the most recent or peat-forming era.

My official duties led me last summer over several hundred miles of the most tortuous coast-line imaginable. Between North and South Uist lies the large island of Benbecula, and about five hundred others of different sizes and shapes; most of these can be approached on foot at low water, and the rest are only separated by shallow channels. On going round the coast I began to notice that the peat banks formed frequently the sea-margin at high water; and feeling that it was a point of some geological importance, I noted the places on my sketch of the coast, till at last finding that the phenomenon was extremely common, occurring perhaps twenty times in a day's walk, it was no longer necessary to record its occurrence. After examining hundreds of examples, I came to the conclusion that, in these instances, there was no other way of accounting for peat banks having that position with regard to the sea-margin, than by the subsidence of the land. In many of the cases referred to the peat rests at once upon the naked gneiss. Now, the surface of the gneiss is as rugged as, and

not very unlike what, the surface of the ocean would be if it were suddenly solidified in the middle of a violent storm. The peat has grown over the undulatory surface, but, as was to be expected, is deepest in the depressions, where I have sometimes seen it in section more than ten feet in height. Let it be supposed that the relative levels of land and sea remained the same until the formation of peat had occurred, and then that the land began to subside. The effect would be that when the sea reached the foot of the peat banks small cliffs would form, identical in their features with those of clay or gravel, or any other soft material. But from the extreme softness of the peat the sea would quickly eat it away, and work itself into all the sinuosities of the surface gneiss that were below the level of high water. This is what has happened around Benbecula; the sea at high water flowing in amongst the knolls, at first forming a simple gap, then branching out like the arms of a tree; at a further stage in the destruction of the peat, a group of islands is formed, till at last the whole vegetable soil is washed away, and a few bare rocks serve to point out where but one generation ago the cattle have pastured and corn has grown. Some of these rocks, which are now completely bare, still bear the names of particular plants that once grew upon them. It is difficult in words to convey an idea of the appearances and of the facts; but an inspection of the coast would show that the peat could only have been brought into its present position by the subsidence of the land. There are, indeed, but two other ways by which the peat can be found to form the sea-coast; one is by the action of the sea upon the shore, the other by the peat advancing to the sea by slip. But neither of these cases will apply to the sea threading in among the knolls and hillocks, eating out holes at first, which become pools, then lagunes, till at last the land that enclosed them is all gone. It must therefore be accepted as a fact, that the land has subsided (and is subsiding) since the peat began to form, and, consequently, that the stone circles of the Lewis are of an age anterior to that subsidence; it follows, then, that if the rate and quantity of subsidence was known, and supposing it to be uniform, we should arrive at the least age of the Pagan monuments.

Although we cannot arrive at the whole quantity, we have fortunately a measure of a part of that subsidence ; this is afforded by what have foolishly been called submarine forests, but which are in fact submerged peat-banks.

In the Orkneys I have noted six places at which submarine peat is said to be found ; at Otterswick, in Sanda, I have seen the people digging it at low water for fuel. The peat was mainly composed of twigs and leaves ; and the seeds of the birch was plentifully scattered through it. There were also many gnarled pieces of wood, of the thickness of a man's arm. I was informed, on describing the kind of peat found at Otterswick, that the same sort of fuel may be got at Balranald, on the west of North Uist, at the level of low water. Peat also occurs below mud and gravel between tidemarks at the head of West Loch, Tarbert, in Harris ; and Martin, the historian of the Hebrides, speaking of Pabbay, an island in the Sound of Harris, says, " The west end of this island, which looks to St Kilda, is called the Wooden Harbour, because the sands, at low water, discover several trees that have formerly grown there. Sir Norman Macleod told me that he had seen a tree cut there, which was afterwards made into a harrow." Several traditions could be added, of places now submerged that were formerly the sites of chapels or houses ; and I think it may be taken as proved, that since the commencement of the peat-forming era, the land has sunk or subsided twelve feet at least ; how much more, there are no means of finding out, for the submarine peat may have grown near to, or far away from, the high-water level ; neither do we know how far the submerged peat-banks extend beyond the level of low water.

From the foregoing facts, it may be inferred that very soon after the climate of the Hebrides became such as to admit of the growth of vegetation, man emigrated to these shores, bringing with him the arts of agriculture and navigation, and a religion that induced him to honour the memory of his illustrious dead. Since then the tanned vegetable mould has accumulated to the height of at least five feet, and also since man's advent here the entire land has sunk twelve feet or more. These data may, by a more extended investigation,

form a measure to the time of his arrival; at present I must content myself with having pointed out the facts.

On the Cervical and Occipital Vertebrae of Osseous Fishes.

By CHARLES ROBERTSON, Demonstrator of Anatomy in the University of Oxford.*

In the present communication I propose giving a description of some peculiarities of the cervical vertebrae, and their appendages, in a few osseous fishes, which, as far as I know, have not before been described, but are of importance in considering the vertebral theory. I shall then proceed to show that the same kind of modifications are met with in the grouping of the elements of the occipital segment of fishes; so that in the skull, as in the vertebral column, the same elements are not invariably present, but are subject to variations.

In dissecting a tunny brought from Madeira by Dr Acland, I observed a very peculiar arrangement of the upper row of ribs† on the cervical portion of the vertebral column. When the upper row was cleaned out and traced forwards, the most anterior rib was found apparently articulated to the upper surface of the exoccipitals, and, as I had never met with ribs attached so far forward as the exoccipitals, I thought that this being an old specimen, the first cervical rib had ankylosed to the posterior extremity of the exoccipitals, and so formed this very peculiar arrangement of parts.

Since that time, by the kindness of Dr Acland and the Dean of Christ Church, three heads were procured from Madeira and forwarded to the Museum at Christ Church, and various sections have been made to illustrate the points noticed in the present communication. On examining a vertical section of the cranium (fig. 1), the basioccipital, 1, is seen to be entirely overlapped by the prolongation backwards of the sphenoid, 4 4. At the posterior extremity of the basioccipital, 1, a small cavity

* Read at the Meeting of the British Association at Manchester, 1861.

† By upper row of ribs, I mean those elements called by Professor Owen appendages, which are generally in the centre of the trunk attached to the lower ribs, and when followed anteriorly and posteriorly, generally terminate on the centra or neural arches of the vertebrae.

is seen in the occipital, with a thin lamina of bone behind, 5, which forms the cup between this and the next centrum, 6. On

Fig. 1.



A vertical section of the posterior part of the cranium and two first vertebrae of a Tunny.
1. Basioccipital. 2. Exoccipital. 3. Supraoccipital. 4. Sphenoid. 5. First rudimentary cervical. 6. Second cervical.

the upper surface of this lamina of bone there is a considerable cavity, which has freely lying in it the neural arch of the first vertebra, which is much smaller than any of those succeeding. The basioccipital, 1, has resting on its upper surface, a pair of bones, 2 (exoccipitals), which form a canal of considerable length, and to the external surface of this canal the first pair of the upper row of ribs is attached. From an examination of four skulls differing much in size and age, I have not found any trace of suture between the posterior portion carrying the first pair of ribs and the more expanded anterior portion; and if such a suture did not exist at an early period of development, these ribs must belong to the occipital segment; for, as I shall show presently, all the vertebrae posterior to this have each their proper ribs articulated to them, and therefore are not displaced elements. As the exoccipitals do not form a part of the cranial walls, but the anterior part of the canal for the cord, they are not in this case cranial bones,—other elements, as I shall show farther on, having taken their place.

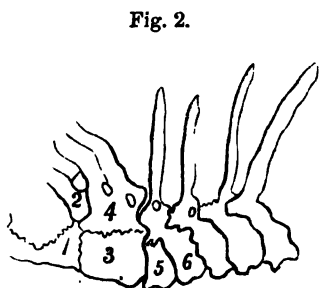
In the tunny, the number of vertebrae, including the first rudimentary, is thirty-nine. The upper row of ribs begins anteriorly on the exoccipitals, and the first and second vertebrae have each a single rib attached to the neurapophyses. At the fourth vertebra, the first of the lower row of ribs is found articulating with the centrum, and the upper rib resting on its head. The same arrangement is continued to the fifth,

sixth, and seventh. At the eighth, the upper row of ribs leaves the lower, and continues attached to the lateral portions of the centrum, till the twenty-ninth, which is the last. The sixth is the strongest and longest, and from it they gradually decrease in size to the last. The lower row is attached to the parapophyses, or the spines formed by their union from the eighth to the eighteenth. The eighth is the broadest and longest, and from it they gradually decrease till the last.

In the pike and eel, two rows are also present; but in them the upper and lower rows never come in contact. The upper row continues attached to the neurapophyses; the lower to the parapophyses. In the bream, the two first vertebræ have ribs attached to long transverse processes. At the third vertebra, the first of the lower row makes its appearance with the upper, articulating to its head. This arrangement is continued till the eighth, when the upper row gradually advances upwards, and continues to be attached to the parapophyses, and the last to the centrum.

An Indian fish (*Synanceia horrida*) presents a very striking instance of the way in which the trunk vertebræ become modified by displacement. The sphenoid does not overlap the basioccipital, 1 (fig. 2), to any great extent, and the under

surface of the cranium presents a smooth, unbroken surface, without elevation or depression. The centrum of the first cervical vertebra, 3, is about three times the length of the second, 5. It carries, besides its own neurapophyses, the neurapophyses of the second, which have become anchylosed together, 4. Each of these anchylosed neurapophyses carries a pair of free ribs, as in



Posterior portion of the cranium and the first six vertebræ of an Indian fish (*Synanceia horrida* ?)

1. Basioccipital. 2. Exoccipital. 3. Centrum of the first vertebra. 4. Neural arches of the first and second vertebræ. 5. Centrum of the second vertebra. 6. Centrum of the third vertebra.

the tunny, and the neural spines are wanting. Each neurapophysis is perforated in the centre by a foramen for the spinal nerves. The centrum of the second, 5, does not carry any

neurapophyses, owing to the prolongation forward of the neurapophyses of the third vertebra, 6, which has come in contact with the second, 5, and by that means pushed up its neural arch, which has fused with that of the first. The first four ribs are attached to the neurapophyses of their proper vertebra; those of the fifth, sixth, and seventh are attached to the centrums. Parapophyses are distinctly developed on the eighth, bending down to form the commencement of the hæmal canal. Ribs are attached to the parapophyses, from the eighth to the eleventh. The ninth carries an additional stunted rib. It will be observed in this case, that it is only on the ninth that two pairs of ribs are met with.

In the pike, the first cervical vertebra carries a neural arch, the upper portions just meeting, but not sufficiently to form a spine. A short and broad rib is anchylosed to each neurapophysis. In front of the first vertebra, covering the foramen magnum, is found, resting on the exoccipital, the neurapophyses of a vertebra without a centrum. In an old pike I found all traces of suture between this first vertebra and the exoccipitals had disappeared, and presented a long canal, prolonged back from them as in the tunny. In the carps, if the bar of bone bounding the posterior extremity of the exoccipitals, and forming the posterior boundary of the very large foramen for the first pair of spinal nerves, which supply the pectoral fins, be traced from above downwards, distinct traces of suture are seen between it and the exoccipitals on which it rests, and on following it upwards, another suture is found dividing it from the supraoccipitals; so that the bars do not meet above to form a complete arch, the supraoccipitals being prolonged back between these two plates, and forming the upper portion of the arch. In the greater number of Cyprinoid skulls this suture was more or less distinct, depending on the age and size of the specimen and species. There can therefore be no doubt but that this bar is the neurapophysis of a vertebra without any centrum of its own, but resting on the basioccipital, and in a much more rudimentary state than that of the pike.* The exoccipitals of the carp are not perforated by un-

* Lord Scarborough very kindly sent to the University Museum some very

usually large foramina, as usually described, but by one only for the eighth pair of nerves.

On the Occipital Segment of Osseous Fishes.

In the examination of the skulls of fishes, it should be borne in mind that the bones forming the upper and posterior portions of the crania exist, in the first place, for the purpose of protecting certain ganglia; and secondly, certain spinous processes are given off from them which serve for the attachment of muscles. Such bones existing for the protection of certain ganglia, and the size of these ganglia depending on the habits of the fish, I have found it convenient to divide them into two great classes—

I. Those active, with a large cerebellum.

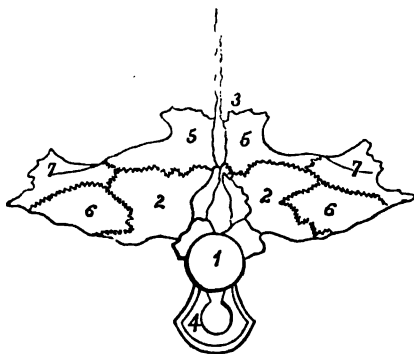
II. Those sluggish, with a small cerebellum.

I hope to be able to show that, in the active, certain bones

are always found, owing to the large size of the cerebellum, but which are not present in the sluggish. As an example of the first division I shall describe the occipital segment of the Tunny, in which the cerebellum is largely developed, and that of the *Lophius* as an example of the second, where the cerebellum is rudimentary.

In the tunny the exoccipitals, 2 2 (fig. 3), cover the whole of the

Fig. 3.



Cranium of a Tunny, viewed from behind.

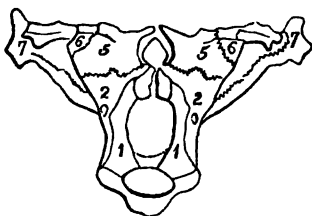
1. Centrum of the first rudimentary cervical.
2. Exoccipitals.
3. Supraoccipitals.
4. Sphenoid.
5. Epiotic (Huxley), paroccipital (Owen).
6. Detached petrosal (Owen), "rocher" (Cuvier).
7. Mastoid.

upper surface of the basioccipital, 1; they meet above in the median line, but are not anchylosed, and expand out laterally, to articulate with the mastoid and petrosal of Professor Owen. On fine carp, which have been of great value in illustrating the osteology of the Cyprinoids.

examining a vertical section, they do not form any part of the cranial walls, but are merely wedged in behind the bones forming the cranial cavity. Resting on the upper surface of the exoccipitals are two bones (parapophyses of Owen),* much larger than the exoccipitals. They meet in the median line, form a large portion of the cranial walls, articulating externally with the mastoid, 7 7, and postfrontals, and in front with the parietals, which have the supraoccipital, 3, prolonged forward between them. Completing the arch above, we have the supraoccipital, 3, which forms but a small portion of the cranial walls, and has a considerable spine prolonged backwards from its central part. It rests on the anterior surface of the epiotics, 5 5, articulating laterally with the parietals, and in front with the frontal. A slender process is sent backwards between the epiotics, 5 5, so as slightly to divide them externally, but it does not prevent their meeting on the internal surface. In some skulls this process from the supraoccipital is wanting. The petrosal, 6 6, of Professor Owen is a bone of considerable size, wedged between the mastoid and the exoccipitals, and receives the lower prong of the suprascapula.

On the upper surface of the exoccipitals, 2 2 (fig. 4), of the *Lophius* rest two bones† of nearly the same shape as those of the tunny. They meet above, form a large portion of the cranial cavity, and send out processes to articulate with the parapophyses of Owen, 5 5, and mastoids, 7 7. On their anterior and upper surfaces they articulate with the parietals, which meet in the median line. A small foramen is observed between the posterior and inner surfaces of the parietal and these two bones. The connections of these two bones in the *Lophius*

Fig. 4.



Cranium of a *Lophius*, viewed from behind.

1. First cervical vertebra.
2. Exoccipitals.
5. Epiotic.
6. Homologous, with so-called detached petrosal of the tunny (6).
7. Mastoid.

* These bones have received the name of Epiotic, from Professor Huxley. (Proceedings of the Royal Society, November 18, 1858.)

† Divided spine of Professor Owen.

are nearly the same as the epiotics in the tunny. In both cases they meet in the median line, and form a large portion of the cranial cavity. I think, therefore, from their connections, that the epiotics of the tunny are homologous with the pair of bones forming the upper portion of the occipital segment in the *Lophius*—the only difference between the two being, that in the tunny the suprascapula has two prongs, the upper of which articulates with a strong process sent outwards from the epiotic; in the *Lophius*, the lower head of the suprascapula only is present, so there is no process sent out from it. From the connection of these bones in the *Lophius*, and their forming part of the cranial walls, I do not see how they can be called divided spines, but a second pair of neurapophyses carried above and in front of the lower pair, forming more or less of the cranial walls, according to the size of the cerebellum, the sides of which they have to protect. It may be asked, if the upper pair of bones of the *Lophius* are neurapophyses, where is the neural spine? I have come to the conclusion, after a careful comparison with the tunny, that in the *Lophius* it is wanting, owing, as I suppose, to the cerebellum being quite rudimentary in that fish. The space left between the parietals and the upper pair of bones affords strong grounds for believing that it is absent. From a comparison of the skulls of various fishes, and keeping the cerebellum strictly in view, I think it will be found that the neural spine is only present in those active species which have a large cerebellum to protect, and that it is always single, and never divided. One great objection to the vertebral theory is the presence of single spines in the trunk vertebræ, and double spines in the cranial segments. I have not been able to find among the authorities on this subject any instance in which the neural spines of the trunk vertebræ are ever double, as they are supposed to be in the cranium, and I think it will be found that the spine is wanting in such sluggish fishes as the *Lophius*, *Lepidosteus*, &c. The skull of a *Lophius* and tunny, which I have before me, are both the same length—nine inches. The occipital segment of the tunny, measuring from the anterior extremity of the supraoccipital to the first vertebra, four and a half inches. In the *Lophius* the same parts are only

two inches. The very great extent of the occipital segment in the tunny, no doubt, stands in relation to the large cerebellum which it has to protect. I have not been able to examine accurately the extent of the cerebellum in the tunny, but that of the mackerel will answer the same purpose, the two are so closely allied. The cerebellum sends forwards a thin, tongue-shaped process, which rests on the posterior surface of the cerebral hemispheres, pushing the optic lobes out laterally, as in birds. In order to cover this tongue-shaped mass, the supraoccipital has to be carried forward with it, pushing the parietals out laterally, which are small, and just sufficient to cover the optic lobes.

From an examination and comparison of the bone called petrosal by Professor Owen, and "rocher" by Cuvier, in the carp, perch, turbot, and cod, with that called parapophysis in the *Lophius*, I have come to the conclusion that the supposed parapophysis of the *Lophius* is homologous with them. It seems to me that great confusion exists with regard to the attachment of the suprascapula, whereas nothing is more simple. When the lower prong only is present, it articulates with a bone between the exoccipitals and mastoid; and when the upper is present, it articulates with the epiotic. This so-called petrosal may be wedged between the exoccipitals and mastoid, as in the tunny, or it may be applied on the upper surface of these bones; but it always retains its relation to them; and where the scapula is attached to the cranium, it is always present as a distinct bone. From the constancy of this bone, and its receiving the lower prong of the suprascapula, which bears a great resemblance to a rib with its head and tubercle, —this bone, therefore, always receiving the head of the rib, is homologous with the parapophyses in the column, and not a bone peculiar to certain species. When the upper prong of the suprascapula is present, it articulates with a process (diapophysis) sent out from the upper pair of neurapophyses, the epiotics. In support of this view, it may be stated that the parapophyses of the trunk vertebrae are often developed from separate centra. The diapophyses cannot be said to exist in the trunk, as there are no tubercles to the ribs. Even where they do exist, they are always exogenous, never autogenous.

It is not my intention, on the present occasion, to follow the bones composing the upper portion of the cranium any farther forward. Many more examples might have been adduced in support of the views presented in this communication; but I have thought it better to take a few common examples, which are within the reach of any one who may wish to investigate the subject for himself. A consideration of the preceding facts will show, that in osseous as in cartilaginous fishes, more particularly at the anterior end of the column, vertebral centra are often met with, carrying two pairs of neurapophyses; and as no displacement has taken place, it cannot be said that each vertebra should consist of one pair of neurapophyses only. As I have shown in the tunny, one of the highest of fishes, the exoccipitals do not take any part in the formation of the cranial walls, but rest on the basioccipitals, to form the anterior portion of the canal for the cord. The epiotics, in this case, form a large portion of the cranial walls, and, in fact, take the place of the exoccipitals, which in this case, and in many others, are not cranial bones at all. So that the occipital segment is not always made up of the same elements, and it is uncertain where the column ends, and where the cranium proper begins. As a termination of this paper, I have drawn up a brief summary of the conclusions I have come to regarding the occipital segment of fishes.

1. The posterior walls of the cranial cavity protecting the cerebellum are not invariably formed by two pairs of neurapophyses, exoccipitals and epiotics. When the exoccipitals take a large share in the formation of the cranial walls, the epiotics are excluded; and when the epiotics are large, and admitted into the cranial walls, the exoccipitals are excluded.

2. The neural spine is only present in the active species which have a large cerebellum to protect, and it is never divided.

3. The petrosal of Professor Owen is found in all species having the pectoral fin attached to the occipital segment, and always receives the lower prong of the suprascapula.

On certain Species of Permian Shells said to occur in Carboniferous Rocks. By Professor WILLIAM KING (Queen's College, Galway), Queen's University in Ireland. (Continued from vol. xiv. p. 45.)

The plan of including in a species two or more groups of forms, each having definite characters, is, in my opinion, disadvantageous in three respects. It involves a cumbrous nomenclature; it is wanting in geologico-chronological precision; and it does not convey to the student any idea of certain persistent characters. Is not "*Spirifera Urei*, var. *Clannyana*," a cumbrous name? Does the name *Spirifera Urei* convey the idea that the particular age of the shell we may be referring to is Permian? And, noticing for the moment a generic consideration, does the name *Spirifera*, which is frequently given to the Permian species in question, express that the shell belongs to a group of *Spiriferidæ*, which is generally without ribs, of an oval or circular form, and furnished with a small area? But by calling the shell *Martinia Clannyana*, we at once get rid of a cumbrous name; we know that it lived in the Permian period; and we have its general outline before us.

Further, the plan is too dogmatic, and altogether unsuggestive of any philosophical conclusions. Admitting, for the sake of illustration, that the Lamarckian or Darwinian doctrine is incorrect, the plan impliedly denies to Creative Power the ability to produce two species, between which it may be difficult to draw the line of demarcation; or in other words, it will not allow of osculant species having been created independently of each other. No—they must be mere varieties, which have been developed by the intervention of extraneous causes. But this is not all. Nearly every recent British species of *Litorina* and *Macra*, if occurring as fossils in palæozoic rocks, would have had their independent creation ignored, and have been respectively named *Litorina variabilis*, and *Macra multiformis*! The plan of itself can only lend a feeble assistance to the palæontologist in enabling him to determine specific affinities, or to take his part in working out the relative order of creation, in Time, of the various organic types which have successively appeared on

the earth's surface. It would, in short, make him little more than a mere species-maker! It would be of no interest that *Martinia Clannyana* lived only during the Permian period; or that under the name of *Spirifera Urei* it existed as a Permian, Carboniferous, and Devonian species;—or whether the genus to which it belongs flourished in several, or only in a few, of the great chronological terms recognised by geologists; or whether it culminated in this or in that period.

In determining fossil species, there are certain considerations to be observed of especial importance. If a group of shells—doubtful as to whether it includes more than one species—belonging to only one system of rocks, assumes a variety of forms, constituting sub-groups, none of which can be distinctively defined, such a group may be practically considered to represent a single species, though there may be a possibility of its containing more than one. We have an illustrative case in *Productus horridus*, a species occurring under several so-called varietal forms, some of which may really be species; but they graduate so imperceptibly into each other that hitherto it has been found impossible to characterise any one of them separately. They are consequently marshalled together as one species by all who have described them. *Dielasma elongata* is another case in point. Possibly some of the species quoted in my "Monograph" are too closely connected with those from which they have been separated to warrant the position they hold in that work; but I cannot admit the same in respect to others. *Dielasma sufflata*, for example, is by form alone distinguished from *D. elongata*, with which it has been confounded; but its individuality, as a species, is further supported by characters which are maintained over a wide geographical area. Another consideration is of equal importance. In *Martinia Clannyana*, we have not only a set of good differentials by which to separate it from *M. Urei*; but non-contemporaneity, besides, of these two species, completes, in my opinion, their distinctiveness. This last consideration causes me to pronounce less decidedly than Mr Davidson as to the Permian *Spiriferina cristata* being specifically identical with the Carboniferous *Sp. octoplicata*.

Definable distinctive characters, if persistent over a wide geographical area, and restricted to a single geological period,

are safe elements in the determination of fossil species. But what other elements might we not have had if such were now living, considering that many existing species of mollusca are, in a great measure, determined by habit, habitat, colour of shell or animal, epidermis, opalescence, and other characters, which it is impossible for a palæontologist to become acquainted with.

The study of existing shells also teaches us that many species have a tendency to simulate the principal distinctive character of others allied to them. Occasionally *Fusus Islandicus* appears with its mammillated apex, resembling the finely-whorled one of *F. propinquis*; *Buccinum undatum* throws off its undulated ribs, and approaches, in smoothness, to *B. Humphreysianum*; *Mya Uddevallensis* loses its posterior obliquity, and becomes squarely truncated, like *M. truncata*; *Astarte Danmoniensis* divests itself of marginal crenulations, and approaches to *A. Scotica*; * *Solen siliqua* curves its valves in imitation of *S. ensis*; and *Lutraria elliptica* loses its marked dorsal convexity, and thus approaches to *L. oblonga*. These twelve species, and some more allied to them, would undoubtedly have been reduced to half their number had they occurred as palæozoic fossils. Other examples of the kind might be cited; but these, I think, are sufficient to show that simulating forms may also occur in a fossil state.†

The references that have been made to recent shells are of a nature to teach palæontologists extreme caution in pronouncing that such and such groups are *not species*, but mere varieties.

On the Origin of Species, &c. By Professor WILLIAM KING (Queen's College, Galway), Queen's University in Ireland.

It would be an insult to reason to deny the power of the Omnipotent to create at once plants and animals out of in-

* I am quite aware that Forbes "excited some little surprise" among naturalists, by uniting as one the two *Astartes* named in the text.

† I am somewhat more inclined to regard the "Bolland shell," noticed in a previous page, as a variety of *Dielsma sacculus*, and simulating *D. suffata*, than as belonging to the last species.

organic or any other kind of matter: on the other hand, it would be equally irrational to doubt His power to ordain and sustain laws by which *originally created* organisms could be adapted to, and modified by, external influences. The two modes may be designated, the first, Autotheogeny;* and the second, Genetheonomy.

Until within the last few years, Genetheonomy was far from sufficiently supported by the arguments of its advocates; those advanced by Lamarck, Geoffroy St Hilaire, and the author of the "*Vestiges*," being only of partial application, or simply illustrated by a restricted group of analogies.† It remained, however, for Darwin and Wallace to enlarge the field of well-sustained argument supportive of creation by Divine law.

But, does the hypothesis of the last named naturalists sufficiently explain the various genetheonomous phenomena? My own reasoning compels me to answer in the negative. I admit the *immediate* efficiency of "Natural Selection" in producing a species; but I cannot divest myself of the impression that it only holds the rank of a subordinate or ancillary agent. The particular view under consider-

* I hold that an organism, whether it typifies a species, a genus, a family, an order, or a class, is an autotheogen, if it possesses any character which isolates it from other equivalent groups: on the other hand, any such groups, through being acted on by inherent or external forces, I am disposed to believe have become more or less modified, thereby giving rise to genetheonomous forms. I do not see why Mr Darwin should not admit the same, notwithstanding his present belief merely recognises among animals "at most only four or five" autotheogenous roots of as many classes. On psychological grounds alone, man must be regarded as isolated from all other organisms; hence I consider him to be an autotheogenous species.

† If organisms underwent changes *only during their embryonic stage*, the author of the "*Vestiges*" would have some grounds for his theory of development "by generation"—by "a universal gestation of nature, analogous to that of the individual being;" but, considering that all organisms undergo, *after their birth, and throughout the entire period of their existence*, successive modifications (less marked, it is true, in the higher Vertebrata than in the Invertebrata and Batrachia), it is manifest that the doctrine of the "*Vestiges*" has nothing in its favour except a restricted group of analogical phenomena. Its author has made out a case of "parity of plan between embryonic development and the succession of life on our planet;" but he has failed, as far as I can understand the theory, in establishing "a real identity of character in the two sets of phenomena."

ation, if I am not much mistaken, implies that plants and animals are modifiable by mere external influences—of course, acting by law. Entertaining this opinion, I am led to regard “natural selection,” as widely removed from the direct action of primary laws; and functionally no higher than chance or accident, as conceived by the untutored.

I feel a difficulty in understanding how “natural selection” could produce a species, unless other and higher principles were involved. Every individual plant and animal is confessedly acted on by forces, the nature of which has never yet been revealed by science. Some conception may be formed of one, paramount in my mind, by designating it “progressive change.” A principle of this kind appears to me to be inherent in animated nature; or how can we otherwise explain the “unity of plan” pervading both organic kingdoms, the “phenomena of parthenogenesis,” the “advance and progress in the main”* which our life system has undergone in past geological ages?

The supremacy of progressive change may be exemplified by referring to the successive modifications which the human organism passes through in its progress towards maturity; while the ancillary or subordinate character of natural selection is well illustrated by the changes which external agencies have effected on the same organism, producing, as admitted by nearly all, the leading varieties of the genus *Homo*.†

* There is no difficulty in citing instances which cannot be reconciled with “an advance and a progress in the main;” but these are obviously exceptional. I cannot agree with Mr Darwin in his view of the “geological record”—of its being so “imperfect” as he seems to think. Many important connecting links, binding in close union all the members of our life system, are undoubtedly wanting; but, in taking a general survey of the facts revealed by paleontology, commencing with the marine fauna of the Taconic period, and closing with that now in existence, it is to me a matter of surprise, considering how limited is the field of observation, that the “geological record” is so perfect. There is apparently some difficulty in accounting for the occurrence of so many invertebrate orders—low as well as high—in Taconic rocks; but we must not overlook the fact that many of these groups now include forms of the simplest type, *doubtful even as to their ordinal rank*; nor must we overlook the probability of the Taconic trilobites, annelids, cephalopods, pallio-branches, corals, &c., being more closely related to each other than is the case with their representatives of later geological periods.

† With respect to the varieties of man, I hold that they are genetheonomous

I am disposed to regard, then, progressive change as one of the great primary modifying principles of organic nature ; and "natural selection" as a secondary one,—the latter immediately operating in the production of *proximately-allied* specific and varietal forms.

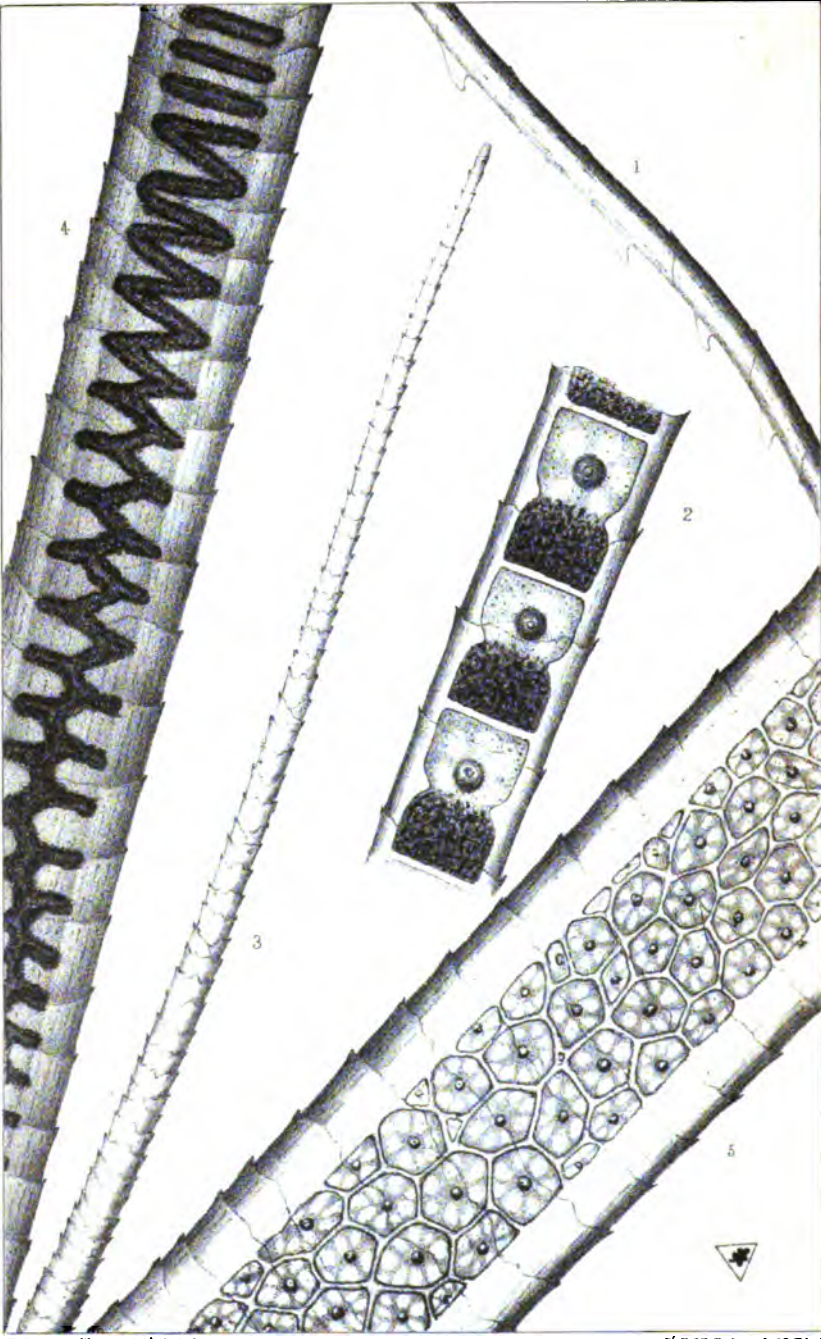
Some years ago I contributed a few facts, which showed that variations of physical conditions, as depth of water and nature of sea-bottom, induced in certain British shells modifications of form equal to differences prevailing between many species of mollusca :* in a paper published a year or two previously, I particularly noticed the remarkable, and, in many cases, imperceptible gradations of generic characters running through the tetrabranchiate Cephalopods:† and in my "Monograph," I have pointed out the various forms assumed by *Camarophoria Schlotheimi*, and some other Permian fossils. These may be taken as evidences that I have not been inattentive to the vexed question of species. Of course, it would ill become any one to dogmatise on the question, and disbelieve in the future turning-up of facts subversive of his preconceived notions ; nevertheless, I feel myself bound to declare, that all my observations and reasoning incline me to believe in the two modes of creation herein advanced.

degradations of the Indo-Caucasian type, developed by the physical conditions peculiar to the regions they respectively inhabit. Cogent reasons may be advanced for regarding the American Indian as having descended from the Mongolian, and the latter from the Indo-Caucasian. Even the aboriginals of Australia may be looked upon as another degraded race. Those inhabiting the south and west coasts are confessedly inferior to other oceanic tribes, as they appear to be incapable of constructing canoes. From some remarks recently made by Professor Jukes, one might be led to attribute this mark of inferiority to the apparent absence in Australia of indigenous timber suitable for canoes (*vide* "Athenæum," No. 1793). I believe, however, a more general cause has operated ; one involving physical conditions. Nevertheless, I certainly prefer accepting the particular circumstance stated, as one of the means which have brought about the degradation of the Australian, to adopting the view which considers him to be a distant "blood-relation" of some extinct ape, even should the remains of species be found hereafter more human-like and more manipulative than the gorilla or chimpanzee.

* See *Annals and Magazine of Natural History*, vols. xviii. and xix.

† See *Ibid.*, vol. xiv.





T. Strevell Wright del. & hth

W. H. M. Parlane, Lith. Edm.

Hair of Angwantibo.

Notice of the "Angwántibo" of Old Calabar, Africa; an Animal belonging to the FAMILY LEMURINA; and apparently a new species of the Genus Perodicticus, of Bennett.
By JOHN ALEXANDER SMITH, M.D.* (Plate III.)

The interesting little animal (now exhibited) was given to me by Mr William Oliphant, who received it some time ago from the Rev. Alexander Robb, one of the U. P. missionaries at Old Calabar. The following extract from a letter, dated Old Calabar, 1st December 1859, gives some details concerning it:—"I was at Creek Town yesterday, and received from 'King Eyo Honesty' a small bush animal; or, as the Krumen call it, 'bush meat,' which I brought with me to give to Mr Thomson, who is with us for a day or two, as he takes a great interest in these matters. He, however, advised me to bottle the animal, and send it to you myself; which, therefore, I now do with pleasure. We have put it up so that it ought to reach you in safety. It is in a stoppered bottle, well sealed, and the bottle is put up in a small tin box wrapped up in our native grass cloth. It seems to be a *lori*, or *Stenops tardigradus*. The Calabar people call it *Angwántibo* (*Angwán* means a farm), but we do not know the etymology of the second part of the word, and cannot say whether it arose from any habit peculiar to the animal. It lives in trees; but, being nocturnal, the people know exceedingly little about it. They cannot tell what it eats. A lad whom I asked said that *he* lived in the house, and *it* lived in the bush; how, then, could he know anything about it? My Krumen also recognised it as a countryman of theirs. They consider the one sent as a young one; and say that in their country it grows to the size of a common puss. Probably theirs is a different animal, but I cannot tell. They call it *Dwán*, and say that it lays down the law to the other beasts, forbidding them to eat the young *fruit* when it begins to form on the trees. If the monkey transgress, the *Dwán* seizes him, and holds him there till he dies,—yea, the monkey rots in his grasp. They say that they are shot together thus. If the monkey gets the shot, the *Dwán*

* Read before the Royal Physical Society, Edinburgh, 25th April, 1859.



holds on ; if the *Dwán* gets the shot, they fall together. The Krumen say that the *Dwán* eats fruit. This is all we know about it at present ; and their (the Krumen's) account seems somewhat fabulous. One of the legs of this specimen is broken. I will send it by the mail that takes this to your address.—I am, &c.,

ALEXANDER ROBB.

“ P.S.—Since writing the above, I have met a youth who professes to know about the *Angwántibo*. He says it sleeps by day, and eats at night ; and that, when full grown, it is as big as an *old cat*, and that it eats fruit.”

In a subsequent letter from Mr Robb, dated 28th February, 1860, he says :—“ I trust you received the *Tardigradus* sent a few months ago. Another specimen which I procured I handed to Mr Thomson, who, I believe, sent it to Mr Murray.”

I have also received from the Rev. H. M. Waddell the following notice, which he had put down in his note-book as descriptive of the “*Angwántibo* :—An animal of the sloth kind, lives in trees, hangs on the branches, and eats fruit. Rather larger, when full grown, than a large cat. Longish snout, short ears, each foot three long crooked toes and claws, with a thumb similarly shaped. No tail. Dun colour ; cannot walk on the ground. When set down, crawls a little, falls over, and rolls itself up in a ball. Inoffensive.”

The animal belongs to the FAMILY of the Lemurs, LEMURINAE s. PROSIMII, and to the first division of the family which is distinguished by Van der Hoeven in his valuable “*Handbook of Zoology*” (translated by the Rev. W. Clark, M.D., London, 1858), as follows :—

PHALANX 1. *Nail of the Index alone of the soles incurved, subulate. Upper incisor teeth four, in pairs.*

A. *With tarsus not elongate.*

Under this great subdivision, it belongs to the

Genus STENOPS, Illig. (genera *Loris* and *Nycticebus*, Geoff.)

Incisor teeth $\frac{4}{4}$, *canines* $\frac{1-1}{1-1}$, *molars* $\frac{6-6}{6-6}$. *Ears short, rounded. Eyes large, approximate. Index of hand short, not longer than pollex. Tail short, or none.*

Van der Hoeven subdivides the Genus *Stenops* into the three following sections:—

(a) *Tail short. Index of hand very short, resembling an unarmed tubercle.* (*Perodicticus*, Bennett.)

(Sp.) *Stenops potto*, *Lemur potto*, Gm., *Nycticebus potto*, Geoffr., *Perodicticus Geoffroyi*, Benn. Gold Coast of Guinea. *Potto*, Bosman.

(b) *Tail very short* (*Nycticebus*, Geoffr.).

(Sp.) *Stenops tardigradus*, Auct., *Lemur tardigradus*, L. Bengal, Siam, Sumatra, Borneo. *Stenops javanicus*, nob., *Nycticebus javanicus*, Geoffr.

(c) *Tail, none* (*Loris*, Geoffr. Body slender; eyes very large, almost contiguous. Nose acute, sub-ascending).

(Sp.) *Stenops gracilis*, *Loris gracilis*, Geoffr., *Lemur tardigradus*, L. Ceylon.

The *Angwántibo* belongs apparently to the first of these subdivisions (a); although, with reference to the first character of this subdivision—that taken from the length of the tail—it agrees better with, and would therefore seem more naturally to come under, the second subdivision (b), still, the distinguishing and peculiar characteristic of the subdivision (a) seems to be the undeveloped index finger, and with this my specimen exactly corresponds. The length of the tail would appear, therefore, to be rather doubtful as a distinctive character; at least, this animal seems to be somewhat intermediate in its characters between the first two subdivisions of the genus *Stenops* as given by Van der Hoeven, viz.—(a) *Tail short; index of hand very short, resembling an unarmed tubercle*; and—(b) *Tail very short*. The *Angwántibo* having the *index of hand very short, resembling an unarmed tubercle*; and also, the *tail very short*. To include it, therefore, the first character of section (a) would require to be altered to—*tail short, or very short; index of hand very short, &c.* It seems to me, indeed, from the discovery of this *Angwántibo* (assuming it to be a new species), that the greater or less length of the tail is not sufficiently distinctive to allow any characters taken simply from it, to be used for the division into *sections* of the comprehensive genus *Stenops* of Van der Hoeven.

The generic character which Van der Hoeven gives of the GENUS *Stenops*—*index of hand short, not longer than pollex*, in the sections (b) and (c), or the equivalent GENERA *Nycticebus*, Geoff., and *Loris*, Geoff.—from the examination I have been able to make of these animals, appears to be due to the *smaller relative size of the metacarpal bone, and the phalanges of the index finger, which are THREE in number, as in all the other fingers (except the thumb)*. In the *Potto*, however, and this *Angwántibo* (as will be afterwards described), which fall under his section (a), and the GENUS *Perodicticus*, Benn., the character of *index of hand very short, resembling an unarmed tubercle*, is due, not only to the *small relative size of the bones of that finger, but also to the presence of only TWO very small phalanges (the same number as in the thumb), the other fingers having three*. This anatomical difference forms a good distinction or character between section (a), the GENUS *Perodicticus*, Benn., and the other Genera, which Van der Hoeven has also included in his great Genus *Stenops*.

The only species noticed by Van der Hoeven under section (a) of his genus *Stenops*, and, as far as I am aware, the only one known, is the *Stenops potto* or *Perodicticus Geoffroyi* of Bennett, and it, like this *Angwántibo*, is a native of Africa; the other described Genera, or species of Van der Hoeven's Genus *Stenops*, are inhabitants of Asia, the East Indies, &c. Van der Hoeven, in his description of this species, the *Stenops potto* or *Aposou*, says—"The *Aposou* or *Aposou* of the negroes of the Gold Coast of Guinea is a nocturnal animal, which sleeps on trees and lives on fruits. The spinous processes of the last five cervical and of the first two dorsal vertebræ are long, and pierce through the hairy integument of the back, with a weak, horny covering. Professor Halbertsma first drew my attention to this peculiarity, which I have observed in two specimens."

On referring to the description of this same species (the *Potto*), placed under the Genus *Perodicticus*, and named *P. Geoffroyi*, by Mr E. T. Bennett, which is published in the "Proceedings of the Committee of Science of the Zoological Society of London," for 26th July 1831 (Part I.,

1830-31). I find the animal now exhibited agrees with the general characters given there of the Genus (correcting the mistake of considering the projecting teeth in the front of the lower jaw as being all incisors, instead of both incisors and canines, according to the present view; and therefore the incisors only four in number, and not six, as Mr Bennett described them). To which I would add, as additional characters of the GENUS *Perodicticus*—tail short, or *very short*; index of hand very short, resembling an unarmed tubercle—*supported by small metacarpal bone, and only two small phalanges*. The *Angwántibo* seems to differ, however, from the details given of the species which he describes,—the measurements of the *Potto*, or *P. Geoffroyi*, given by Bennett, being, “length of head 2 inches and $\frac{1}{8}$ ths; of the body 6 inches; of the tail 1 inch $\frac{1}{8}$ ths, or, including the hair, 2 inches $\frac{3}{8}$ ths;” whereas, in my specimen, the whole length, from point of muzzle to extremity of tail, is about $10\frac{1}{2}$ inches; the tail being only $\frac{1}{4}$ of an inch in length, or, including the hair, which is about $\frac{1}{2}$ of an inch long, only $\frac{1}{2}$ an inch. The animal described by Bennett was immature, its dentition not being perfect; in the one now exhibited, the dentition is perfect. There seems to be other slight differences between the *Potto* and the *Angwántibo*, in the colour of the hair as well as in the relative size or proportions of the body and limbs, which I shall afterwards notice in describing this specimen; and, while at present unable to procure various works for reference, or a specimen of the *Potto* itself for examination (and therefore in want of more information on the subject), I am inclined to consider this specimen of the *Angwántibo* as being a mature individual, and probably forming another species of the same genus, and one, that so far as I am aware, has not before been described, I therefore, from the locality where it was found, give it provisionally the name of the *Stenops*, or *Perodicticus Calabarensis*.

The *Potto*, or *Perodicticus Geoffroyi*, is found at Sierra Leone, a region of the African coast, at some distance from Old Calabar. It is also known by a different name, being the *Aposo* or *Aposou* of the Gold Coast. The letters of the missionaries (from which

extracts were given at the commencement of this communication) seem to indicate the possible existence of more than one species, probably of allied animals—the *Dwän* of the Krumen, and this, the smaller *Angwántibo* of the natives of Old Calabar. Whether the *Dwän* and the *Aposou* are the same, or different species, I am unable to determine: they probably bear a considerable resemblance to one another. From the great variety in size of the animals referred to in these letters, I am at present inclined to believe there may be two, if not three, distinct species,—the *Aposou*, the *Dwän*, and the *Angwántibo*,—the *Dwän* being perhaps the largest in size.

Description of the ANGWANTIBO (from specimen in spirits:)—*Perodicticus Calabarensis* (Mihi)—*above, yellowish-brown; the roots of hair dark gray; below, paler, in some parts nearly white; hair wool-like; length from muzzle to point of tail, 10½ inches; tail very short, (about ¼th of an inch in length).*

Proximal phalanges of both hands and feet (not including the pollex) united together by the integuments; the two distal phalanges being free.*

The *Angwántibo* is covered with a thick and long wool-like hair, which becomes short and thin on the face and on the extremities, the inner sides of the fore and hind hands being free from hair. The hair is of a dark gray colour at the base, and the upper third or so of its length is of a light brown or fawn colour, the terminal points being of a darker brown; this is the general character of the fur of the upper parts of the body and limbs. The face in front of the eyes is rather darker in colour, but the sides of the head are lighter, and the chin and throat are nearly white. The inner surface of the limbs is also lighter, as well as the whole under surface of the body, the gray hairs having their distal half of a light fawn colour, and in some places nearly white. From the specimen

* A hand of the *Potto*, figured in "Cuvier's Animal Kingdom"—London, 1849 (Mammalia, &c., with Notes, by Edward Blyth), shows no such conjunction of the first phalanges, three distinct phalanges being figured in each of the fingers.

having been for a long time preserved in spirits, it is difficult to get at the minute details of colour. There are no stripes or markings on the back, or other parts of the body, of this animal, as on the *Stenops tardigradus* of the East Indies; its general appearance being more uniform over the surface, although somewhat mottled in character, from the hair varying in colour at base and apex.

The BODY of the *Angwántibo* is slender, and measures $10\frac{1}{2}$ inches in length from the point of the muzzle to the extremity of the very short tail, which is completely hid in the long fur of the body, and measures only about $\frac{1}{4}$ th of an inch in length. This animal is a male; the penis, which is supported apparently by a small bone, projecting upwards and forwards from the rounded scrotum.

The HEAD is oval and rounded, tapering rapidly in front of the eyes; the muzzle protruded, full or blunt, and rather prominent. The breadth of the head, in front of the ears, is about $1\frac{1}{2}$ inch; in front of the eyes, about $\frac{3}{4}$ ths of an inch. The length from the mesian line of the nose to the anterior part of meatus of ear is $1\frac{1}{2}$ inches; from point of nose to anterior angle of the eye is $\frac{3}{4}$ ths of an inch; from anterior angle of eye to front of opening of ear, $1\frac{1}{2}$ inch,—the total length of head from muzzle, to back part, being nearly $2\frac{1}{2}$ inches. The EYES are rather full and large, the opening of the lids measuring $\frac{1}{2}$ an inch in length; the distance between the eyes at their anterior angles is $\frac{1}{2}$ an inch. They are rather prominent forwards, and very slightly lateral. The EARS are erect and patulous, rather large, and rounded in outline, without emarginations, measuring about $\frac{3}{4}$ ths of an inch across from before backwards, and also from above downwards; they seem to be naked internally, and slightly covered with short hair externally. In this specimen they are nearly naked, especially on the inner surface. There are two transverse, abrupt, parallel, projecting ridges of cartilage, each measuring $\frac{1}{4}$ ths of an inch in length, in the free cartilage above the external opening of the meatus. The external openings of the NOSTRILS are rather lateral, and are sinuous, curved upwards and inwards toward the mesian line of the full and rounded snout; and there is a groove

between them, running down to the front of the upper lip. The TONGUE is long, rounded in front, and rather rough, being covered with small papillæ. Immediately below the tongue is the projecting lamina, covered with a horny cuticle, and resembling a smaller, bird-like tongue, which springs from the frenum and projects forwards, about $\frac{3}{8}$ ths of an inch in length. It is free at its edges, and at its point, which projects about $\frac{1}{8}$ th of an inch; reaching to within $\frac{1}{4}$ th of an inch of the point of the tongue itself. This horny lamina measures about $\frac{1}{4}$ th of an inch in breadth across its root or base, and about $\frac{1}{8}$ th of an inch across its free or front extremity, which is divided into nine sharp terminal points or filaments. The *P. Geoffroyi* is described by Bennett as having this horny lamina terminating in about six filaments. It is difficult to understand the use of this strange supplementary horny, bird-like tongue, or expansion of the frenum, with its pointed terminal filaments, in an animal stated to feed on fruit; it would seem rather to be some sort of additional assistance towards capturing or killing an insect prey; but, in any view, its use seems to be very obscure. Below the tongue and this supplementary organ, the mucous membrane lining the floor of the mouth has a slightly free margin projecting along the sides of the gums of the lower jaw; in which, apparently, the ducts of the submaxillary gland (Wharton's ducts) open into the mouth.

The NECK is rather short and slender. There is no appearance on the back of the neck in this specimen "of the spinous processes of the five last cervical and first dorsal vertebræ, piercing through the hairy integument of the back, with a weak horny covering," as described by Van der Hoeven of the *Stenops potto*.

The LIMBS are very slender, and nearly equal in length, the hinder extremities being a little larger and stronger in their development than the anterior. The FORE HANDS (see fig. 1 of the annexed careful drawings, nearly the size of life, for which I am indebted to my friend, T. Strethill Wright, M.D.) are thinly covered with short hair on the dorsal, and are bare of hair, or naked, on the palmar surface. The thumb is much larger than any of the other fingers, to

which it is opposed. There is a large rounded, fleshy, and horny tubercle, nearly $\frac{1}{4}$ th of an inch broad at its base, projecting about $\frac{1}{4}$ th of an inch, from the base of the thumb, on the inner side (next the centre of hand). Immediately opposed to it, and of equal size, or a very little larger, is another apparently simple tubercle, rising from the outer side (next thumb), of the base of the clustered fingers (see * fig. 1); this, however, is the rudimentary index finger, its free extremity projecting only about $\frac{1}{8}$ th of an inch. It is supported by a short metacarpal bone, with a full and rounded extremity, to which are attached *two* small or rudimentary phalanges; each of the other fingers (not including the thumb), having *three*. This rudimentary



Fig. 1. Hand.

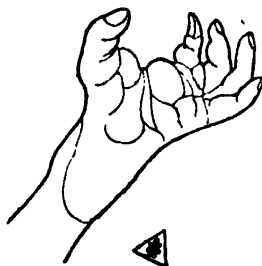


Fig. 2. Foot.

ANGWANTIBO.

index finger has no nail; there is simply a minute marking, like a cicatrix, or rather a mere short, depressed, smooth line, an indication of where a nail should be. The nails of the thumb and other fingers are all thin, flat, and rounded or ovate, like those of the human hand, and are not extended beyond the points of the fingers. The remaining three fingers are slender and prolonged, and the first phalanges are all conjoined by the integuments, the two distal phalanges of each finger alone being free. The index or second finger (considering the thumb as a finger) is, as already described, merely like a tubercle rising at the base of the others. The third finger is the smallest of the other three fingers, and also the shortest; the fourth (or middle of the developed fingers) is the longest; and the fifth, or last, is longer than the third.

The hands are each divided into two portions; the thumb, with the tubercle at its base, being opposed to the fingers with the tubercle-like index at their base: the thumb itself being brought into opposition to the fourth, the middle or longest of the fingers.

The *posterior hands* or *feet* (see fig. 2, which also shows the length of the tarsus) are rather larger and stronger than the anterior ones, and are each divided into two opposing portions; the one consisting of the thumb, with a large, rounded, fleshy tubercle projecting from the inner side of its base, as in the fore hand; and the other portion, formed of the remaining four fingers, the first phalanges of which are also conjoined, being covered by the integuments, as in the hand. There is a comparatively smaller fleshy tubercle, somewhat like the undeveloped index finger of the fore hand, projecting from the outer side of their base, which is opposed to the tubercle at the base of the thumb. It is not supported by any bone, but is merely a horny and fleshy projection like that on the base of the thumb. The nails of the thumb and fingers are thin, flat, and rounded or ovate in form, like those of the fore hand, with the exception of that of the second finger (counting the thumb as the first), which is narrow, convex, sharp-pointed, and claw-like, and extends nearly to the point of the third finger, this claw-like nail, indeed, constitutes one of the distinctive characters of the FAMILY. In the *P. Geoffroyi* of Bennett, the claw-like nail on the second finger appears to be 1 inch and $\frac{1}{10}$ ths in length (the finger being stated to measure $\frac{1}{8}$ ths of an inch, or, including the nail, 2 inches $\frac{1}{8}$ ths); whereas, in the *Angwántibo*, the whole length of the free extremity of the finger is half an inch, including the claw-like nail, which measures rather less than a quarter of an inch.

The hands and feet have been already mentioned, as being each divided into opposing portions. They remind one of the zygodactylic feet of the Climbing-Birds; and this character, taken along with the existence of the *rete mirabile* of the limbs (the tortuous and anastomosing plexuses of vessels, which exist in this animal, as well as in others of its class), and the arboreal habits of the creature (for so completely does it dwell among the branches of trees,

that it is stated by one of the missionaries to be scarcely able to walk on the ground)—all seem to tell of long-continued muscular action, a capability of taking a safe, sure, and long-enduring hold; and, probably, like others of its class, of a stealthy step, which may enable it to steal upon, and hold fast, an active and vigilant prey. The incident mentioned by the missionaries, of the *Dwān* seizing animals like the monkey, is very curious; as we cannot help thinking they must be seized and held fast for a somewhat different purpose than merely to prevent them destroying the young and unripe fruit, on which they both are said to feed. The dentition of the *Angwántibo*, to be afterwards detailed, would make us incline to the belief of its food being of a more mixed character than simply fruit, and that it probably included at least insects or their larvæ (for the capture of which the peculiarly complicated lingual apparatus may afford special facilities); or possibly, the smaller birds, which, from its nocturnal habits, it may also steal upon and capture, while they are quietly roosting among the branches of the trees. The structure of the feet, however, and the apposition of the thumb to the middle of the fingers, seem to show an adaptation for seizing forcibly the twigs of trees, rather than for the purpose of capturing a prey.

I subjoin details of the dentition of the *Angwántibo*; and also some of its admeasurements. For the relative measurements of the *Potto*, corresponding to those described of the *Angwántibo*, and showing their various differences, see Bennett's account of the GENUS *Perodicticus*, referred to already.

DENTITION.

UPPER JAW:—

Incisors $2 \cdot 2 = 4$. Two together (in pairs), with intermediate edentulous space,—1st incisor the smallest, the 2d nearly twice as large as the first.

Canines $1 - 1 = 2$. Large and projecting downwards. The intermaxillary suture is described as being immediately in front of the corresponding teeth of the *Potto*; these teeth are therefore undoubtedly canines, and when the mouth is shut,

they pass immediately behind the small canines which project forwards alongside the incisors of the lower jaw.

Molars $6 \cdot 6 = 12$.

(False Molars, 3.) *1st*, smallest, conical; with very small and slight indication of an internal conical tubercle: *2d*, conical; with small internal conical tubercle: *3d*, with external conical tubercle; and smaller, shorter, internal tubercle.

(True Molars, 3.) *4th*, with two external conical tubercles; and two internal smaller and flatter tubercles: *5th*, two external conical tubercles; and two internal, smaller and flatter ones: *6th*, two external conical tubercles; and one internal flattened and smaller tubercle.

LOWER JAW:—

Incisors $2 \cdot 2 = 4$. In pairs laid closely together, the pair appearing like one tooth, and all sloping forwards.

Canines $1 \cdot 1 = 2$. Small, sloping forwards adjoining incisors, which they closely resemble. Each tooth, however, is slightly larger in size than a pair of the incisors.

Molars $6 \cdot 6 = 12$.

(False, 3.) *1st*, large, conical, projecting forwards and upwards like a canine tooth in shape (the corresponding tooth in the *Potto* was formerly described as a canine tooth). When the teeth are closed, the canine of the upper jaw passes in front of this tooth, it is therefore the first molar; *2d*, smaller than first, shorter, conical, and pointed forwards; *3d*, rather larger than second, conical.

(True, 3.) *4th*, two external and two internal tubercles, nearly equal in size; the internal rather the largest; *5th*, two external; and two internal and rather larger tubercles; *6th*, two external; and two internal tubercles, nearly equal, and less defined; with another smaller tubercle behind.

Incisors.	Canines.	Molars.
$2 \cdot 2 = 4$	$1 \cdot 1 = 2$	$6 \cdot 6 = 12$
$2 \cdot 2 = 4$	$1 \cdot 1 = 2$	$6 \cdot 6 = 12$
		$12 = 18$
		$18 = 36$

Length of Body, from muzzle to point of tail, $10\frac{1}{2}$ inches; tail, $\frac{1}{4}$ an inch, including fur, $\frac{1}{2}$ an inch.

ANTERIOR LIMBS:—

Length of Arm $2\frac{1}{4}$ inches; *Fore-Arm*, not including hand, $2\frac{1}{4}$ inches.

Hand.—The first phalanges of the fingers are covered and conjoined by the integuments of the hand, the two distal bones being the only ones that are free; length from wrist to point of fourth or longest finger, $1\frac{1}{4}$ inch.

Length of Thumb, or First Finger, from wrist, $\frac{3}{4}$ ths of an inch: of this, there is a free extremity of $\frac{1}{2}$ an inch in length.

Length of Index or Second Finger.—Metacarpal bone of index finger measures $\frac{1}{3}$ ths of an inch in length. The first phalanx measures $\frac{1}{3}$ ths of an inch, and the distal phalanx $\frac{1}{3}$ th of an inch in length; the metacarpal bone of index finger and first phalanx being, together, the length of the metacarpal bone of the second finger. The metacarpal bones of the other fingers measuring about $\frac{1}{4}$ ths of an inch in length. Free extremity of finger about $\frac{1}{3}$ th of an inch.

Length of Third Finger from wrist, $\frac{3}{4}$ ths of an inch. The first phalanx of third finger measures $\frac{1}{4}$ ths of an inch; the second phalanx less than $\frac{1}{3}$ ths of an inch; and the distal one rather less than $\frac{1}{3}$ ths of an inch. Free extremity is $\frac{1}{4}$ of an inch.

Length of Fourth Finger from wrist, $1\frac{1}{4}$ of an inch. The first phalanx is nearly $\frac{1}{3}$ ths of an inch long; the second, $\frac{1}{3}$ ths of an inch; and the third, about $\frac{1}{3}$ ths of an inch. Fourth finger longest, free extremity $\frac{1}{2}$ an inch in length.

Fifth Finger.—Length from wrist 1 inch. The first phalanx is about $\frac{1}{3}$ ths of an inch in length; the second, $\frac{1}{3}$ ths of an inch; and the third about $\frac{1}{3}$ ths of an inch. Free extremity $\frac{3}{4}$ ths of an inch.

SPAN, 1 inch and $\frac{1}{8}$ ths of an inch.

POSTERIOR LIMBS:—

Length of Thigh, $2\frac{1}{2}$ inches; of *Leg*, $2\frac{1}{2}$ inches.

Foot, from ankle-joint to point of longest finger or toe—the fourth, $1\frac{1}{2}$ inch. *Tarsus*, not elongated, about $\frac{1}{2}$ an inch in length. *Metatarsal bones* measure from $\frac{1}{8}$ ths to $\frac{1}{8}$ ths of an inch in length.

The first phalanges (with the exception of the thumb), like those of the hand, are conjoined together.

Thumb or First Finger.—Thumb with metatarsal bone, about $\frac{3}{4}$ ths of an inch long. First phalanx, $\frac{1}{8}$ ths of an inch; second, $\frac{1}{8}$ ths of an inch.

Length of Second Finger, 1 inch; first phalanx, nearly $\frac{3}{4}$ ths of an inch; second phalanx, $\frac{1}{8}$ ths of an inch; third phalanx, bone of claw, $\frac{1}{8}$ ths of an inch; claw itself, $\frac{1}{8}$ ths of an inch. Free extremity, $\frac{1}{2}$ an inch.

Length of Third Finger, first phalanx, $\frac{1}{8}$ ths of an inch; second phalanx, $\frac{1}{8}$ ths of an inch; third phalanx, $\frac{1}{8}$ ths of an inch; third finger smaller than the fifth, and free about $\frac{3}{4}$ ths of an inch.

Length of Fourth Finger, first phalanx, $\frac{3}{4}$ ths of an inch; second phalanx, $\frac{3}{4}$ ths of an inch; third phalanx, $\frac{1}{8}$ ths of an inch; fourth finger longest, free about $\frac{1}{2}$ an inch.

Length of Fifth Finger, first phalanx, $\frac{3}{4}$ ths of an inch; second phalanx, $\frac{1}{8}$ ths of an inch; third phalanx, nearly $\frac{1}{8}$ ths of an inch. Larger than third finger, being intermediate between it and the fourth, and free for about $\frac{3}{4}$ ths of an inch.

SPAN measures nearly 2 inches in length.

This animal possesses a clavicle. The stomach is moderate in size, and rounded in form, and contained what seemed to be digested vegetable matters. It has a large sacculated cœcum of about $1\frac{3}{4}$ ths inch in length.

MICROSCOPIC STRUCTURE OF THE HAIR OF ANGWÁNTIBO.

On examining through the microscope some of the hairs of this little animal, I was much struck by their apparent variety and beautiful cellular structure. Plucking a few at random from the upper surface of the body, I found I had got three different varieties: large flattened hairs, showing a combined series of cells; smaller hairs, containing a single series of cells; and each displaying the external or epithelial coating of the hair, which forms a series of overlapping margins or scales, their free edges being directed towards the points of the hair; and, lastly, small bent or curved

solid horny-like hairs, with this overlapping external coating developed here and there into large hook-like processes or spines. At my request, my friend Dr T. Strethill Wright made a minute microscopical examination of these hairs, and sketched the accompanying careful drawings (see Plate III.), which show very well their beautiful structure. Dr Wright used simply water in examining some of the hair; and this fluid entering by the cut extremities, and permeating the hair thoroughly, distinctly revived and exhibited their internal cell structure. In the smaller-sized hair, containing only one series of cells, the cells are found to have an hour-glass contraction in the middle, the lower half of the cell containing the colouring-matter of the hair, and the upper part of the cell displaying a distinct central nucleus, the existence of which, at least in the body of the hair, is a fact which was new to both of us, if not altogether new to microscopists in general? These nuclei were also beautifully seen in the cells of the larger hairs. Dr Wright has figured (Plate III. fig. 4) the peculiar appearance which some of the hairs displayed, of black bars, arranged in a somewhat parallel manner, or zig-zagging from one extremity to the other, in the central portions of the bodies of the hair; for the lower, and upper portions of all the hairs, showed no cell cavities, being formed apparently of solid structure. These black bands were due to some of the uncut hairs being mounted in turpentine or balsam, which did not permeate the hair like the water, but obscured their true structure altogether, by enclosing the air as a black band, which was varied both in shape and contiguity, in the lacerated cells of the hair.

Thick hair or fur of a cellular structure containing thus enclosed a considerable amount of atmospheric air, a bad conductor of heat, and therefore useful in preventing the rapid cooling of the body of the animal, has been believed to be peculiarly adapted as a covering for animals inhabiting cold climates; it seems, however, to be not inappropriately found on this little animal, which is stated to search for its food by night, and is therefore exposed to the damp and cold which occur at night in even a tropical forest.

Annexed is Dr Wright's detailed description of Plate III.

DESCRIPTION OF PLATE III.

- Fig. 1. Proximal portion of small hair in water, showing the recurrent spines.
2. Middle portion of small hair in water, showing hour-glass-shaped cells, one-half of which is occupied by pigment, the other by the nucleus and vacuolated "cell-contents." Diameter about .001 inches.
 3. Summit or solid portion of large hair, showing contracted scales.
 4. Upper part of large hair in turpentine, showing dark spaces filled with air, formed by the shrivelling of the cell contents, of single and double row of cells. Diameter about .006 inches.
 5. Middle or broadest part of large flat hair in water, showing single layer of cells, with nucleus and vacuolated cell-contents. Diameter .009 inches.

The Society may think I have entered rather too much into minute details of description. My reason for doing so, is to leave no doubt on the mind of any one, who may wish to make comparisons between this *Angwántibo* and any other individual of the genus, as to the special animal I have attempted to describe; and, for preservation, it is my intention to deposit the specimen in the Natural History Museum, University.

Since the preceding pages were written, I have been fortunate enough to get this specimen of the *Angwántibo*, and my detailed description, compared with the *Potto* described by Mr Bennett; and also with other specimens of the *Potto* in the collections of the British Museum—my friend, Mr William Carruthers, of the Botanical Department of that great national institution, having, at my request, kindly taken the trouble of examining them.

Mr Carruthers informs me I am correct in my opinion of the *Angwántibo* being a distinct species from the *Potto*, the *Perodicticus Geoffroyi* of Bennett; and also that it is a species apparently unknown to naturalists. I am therefore at liberty to designate it the *Perodicticus Calabarensis*.

Mr Carruthers says:—"It is certainly a *second* species of *Perodicticus*. I compared it with two stuffed specimens of the *Potto*, and, with the assistance of Dr Gray, determined that it was *new*, differing chiefly from *P. Geoffroyi* in its tubercle-like tail and large ears. I also got Mr Bennett's specimen of

the *Potto*,—which is yet fortunately in spirits,—and have been able more completely to discriminate the differences.”

At my desire, an artist made sketches of the head of Mr Bennett's specimen of the *Potto*, and also of my specimen of the *Angwántibo*, to show the various differences between

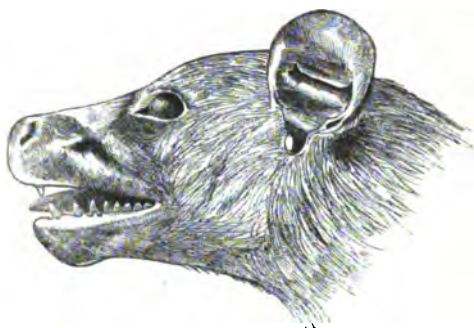


Fig. 3. Head of Angwántibo

them, in a more manifest way than by any lengthened description; and as both the specimens have been preserved in spirits, these comparative differences are seen at a glance,

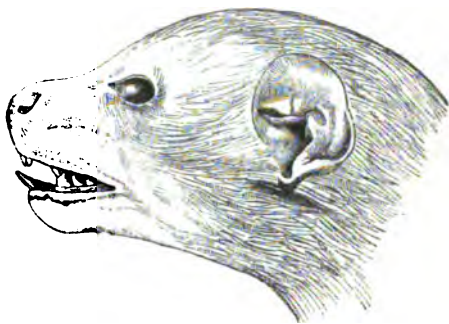


Fig. 4. Head of Potto.

no change in the original appearance of either having been made by any attempt at skinning, or otherwise preparing them for preservation. The sketches are of the natural size, and very accurate, being drawn without any attempt to put

the hair in its natural position. In this way two things are gained. First, both specimens are exhibited as they really are, without any exercise of the imagination of the draughtsman; and, secondly, the outline of the skull is given in both, which is of much more importance than the outline of the hair, in animals where the hair is thick and stands nearly erect. The preceding woodcut (fig. 3), is the sketch of the head of the *Angwántibo*, the other (fig. 4), that of Mr Bennett's specimen of the *Potto*.

In pointing out the various specific differences which the comparison of the two specimens make manifest, Mr Carruthers says, in the *Angwántibo* the body and limbs are more slender than in the *Potto*, and the colour of the hair is more uniform. The head is longer and narrower, with a more produced muzzle, larger mouth, and more prominent eyes; while in the *Potto* (see woodcut), the head is nearly round, and has a much less projecting muzzle. Again, the ear is larger, and directed more upwards and forwards in the *Angwántibo*; and there are two folds, as already pointed out, in the inner surface of the ear; while there is only one in the *Potto*. The drawings show also the remarkable differences in the teeth. The teeth in the lower jaw, which Bennett described as the canines in the *Potto*, but which are now considered as pre-molars, are mentioned by him as having cutting surfaces, both before and behind, they are, in fact, small, flat, triangular teeth; whereas in the *Angwántibo* they are long, rounded, and more canine-looking. Then the six teeth in the front of the lower jaw, in the *Angwántibo*, are small and hyaline, not visible above the under lip; while in the *Potto* they are large, prominent, and projecting (see woodcuts), and of the same colour as the molars.

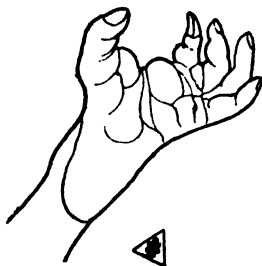
There is also a very striking difference in the hands of the two little animals. Mr Carruthers has been good enough to make the annexed careful sketches, the size of life, of the hand (fig. 5), and the foot (fig. 6), both belonging to the left side, of Mr Bennett's specimen of the *Potto*, (see woodcut, figs. 5, 6); and on comparing these sketches with those already given of the *Angwántibo*, which, for comparison, I here

repeat (figs. 1, 2), the differences will be seen more clearly than could be brought out by any description. In the *Angwántibo* the hands and feet are small, round, and fleshy, with several large pads; in the *Potto* they are large, flat, and thin. In both, as has been already carefully described, the index fingers of the fore hands are undeveloped; being represented in the *Angwántibo* by a simple tubercle (see * fig. 1.) In the *Potto*, however, as shown in the drawing, the index is not so like a mere tubercle, but is more developed, and therefore more resembling a finger, than in the *Angwántibo*, (See * fig. 5.)

The tail is perhaps the most striking distinguishing character. I have already sufficiently described it.



Fig. 1. Hand.



ANGWANTIBO.

Fig. 2. Foot.

Mr Carruthers informs me that when examining the different species of Van der Hoeven's genus *Stenops*, in the British Museum, he was struck with the great diversity of their general appearance, and was astonished that a zoologist like Van der Hoeven grouped together what appeared to him to be several well-marked *Genera*. Indeed, the only explanation that occurred to him was, that Van der Hoeven intended to give the character of a SUB-FAMILY to his *Genus Stenops*.

While comparing the specimens of these two animals, he had on his table all that had been published on the *Potto*. Bosman's figure is a grotesque caricature of a fat and lazy animal, having a very faint resemblance to the *Potto*. Van der Hoeven gives a drawing of the skull in the "Tydschrift voor Nat. Gesch.," vol. ii. plate i. fig. 3, and of a young

animal, in plate ii. ; also a very full account, with drawings of an adult, and of the skeleton, brain, and viscera, in a paper in *Verhand. der Eerste Klasse van het Kon. Med. Inst. IV.* 1851. More recently, in 1856, Dahlbom, in his "*Studia Zoologica*," gives a figure and description of the *Potto*. He divides the *Lemuridæ* into three sections. First, the true *Lemurs*, with long tails ; second, the *Lorids* (*stenops*), without tails, and with long limbs ; and third, those with very short tails, or almost tail-less, oval or globose heads, and short fleshy arms. Here he has two genera :

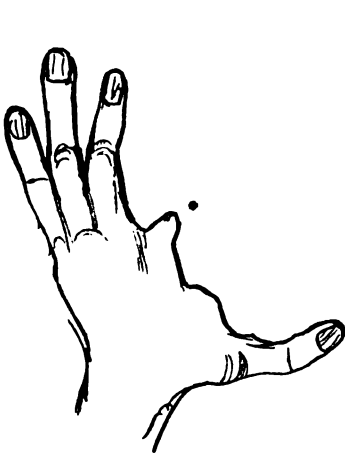


Fig. 5. Hand.

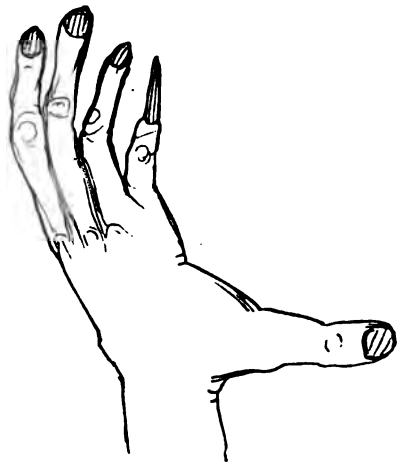


Fig. 6. Foot.

POTTO.

I. *Perodicticus*, characterised thus : "Caput ovale, ore crasso obtuso. Aures liberæ. Oculi subparvi. Index manus antice abortus, in tuberculum coarctatus." And, II. *Nycticebus*, "Caput globosum, ore conico. Aures in pelle absconditæ oculi magni. Digiiti normales."

I may mention, in conclusion, since this paper was in type, I find that Van der Hoeven made a short communication on the *Potto* to the Meeting of the British Association in 1850, and a second on the anatomy of the *Potto* in 1860, in which he refers to a complete monograph of this animal published by him in 1859, in the seventh volume of the *Transactions of the*

Royal Academy of Sciences of the Netherlands (Ortleedkundig Ondersock van der Potto van Bosman door F. A. W. Van Campen Med. Cand. Uit due Platen Amsterdam. 4to, 77 pp.) Van der Hoeven also details his arrangement of the *Lemuridæ*, published in his "Handbook of Zoology," and refers again to the peculiarity in the *Potto*, "that some of the spinous processes of the neck, covered only by a thin corneous epiderm, pierce through the fur-like prickles. They are those of the fifth to the last cervical, and of the first two dorsal vertebræ." These projecting processes are evident, Mr Carruthers informs me, in Mr Bennett's specimen, though, probably from its youth, neither so numerous nor so strongly marked as Van der Hoeven describes them. They cannot be detected in the two *stuffed* specimens in the British Museum, as might have been expected; as already stated, I could not discover this peculiarity in my specimen of the *Angwántibo*.

I have been recently favoured with the following explanation of the name *Angwántibo*, from the Rev. Alexander Robb :—"The name *Angwá-ntibo* is compound; the first part is the same as the name of the domestic cat, which the Calabar people call *Angwá*, or *Angwá-mbána*—the *ng* being a very soft nasal sound. *Angwá* is probably onomatopoetic, from its resemblance to the sound of the mew or cry of the cat. The meaning of *ntibo* is unknown to me. The *Angwántibo* is, therefore, so named, probably because it is supposed to resemble the cat, either in its cry or in some of its habits. We give this note as a correction of the etymology proposed in the letter at the beginning of the above paper."

REVIEWS AND NOTICES OF BOOKS.

Vis Inertiæ Victa; or, Fallacies affecting Science: an Essay towards increasing our knowledge of some Physical Laws, and a Review of certain Mathematical Principles of Natural Philosophy. By JAMES REDDIE. London: Bradbury and Evans. 1862.

It is a curious peculiarity of the present age, so distinguished above its predecessors for the diffusion of knowledge on almost every subject—that perpetual-motionists and squarers of the circle, as well as trisectors of angles and duplicators of the cube, are becoming more numerous day by day. Within the last month we have been favoured with communications from four inventors of self-sustaining engines, and two of methods of obtaining eight or ten horse power from one horse. We have also had mysterious hints about the area of a circle; and have been asked whether the fortunate discoverer is not entitled, by the universal law of nations, to a reward of one million sterling. But all these communications have been sent to us in trust, the happy authors hoping that their secret would be safe with us. So it is and shall be. Unread, or but glanced at, the precious pages have been torn into pipe-lights, the waste-basket seeming scarcely to afford the honourable silence demanded. Thus has perished in its innocence the progeny of many a simple mind, the result, perhaps, of years of persevering but misdirected toil.

In the present instance, however, we are called upon publicly to pronounce upon the merits of a tremendous discovery, destined, as its author sadly fears, to strip the overrated Newton of his undeserved honours, and to revolutionise at once the laws of nature and the processes of mathematics. Here is no timid discoverer shrinking from the light of day, blushing to find himself famous; but, instead, the calm consciousness of power, and the kindly patronising language of unquestioned superiority.

In his superhuman struggles with the *Vis Inertiæ*, Mr Reddie has laid about him so freely in all directions, that the laws of motion, gravity, heat, cohesion, and a host of other still less interested spectators, have had their share of the slashes. Nothing is secure, and we rise from a perusal of his book with a dreamy consciousness that something has gone wrong; that there is a screw loose somewhere, whether in the system of the universe, or in the brains of a Newton—or a Reddie.

But let us look a little closer into matters. The following seems to be the sentence which has suggested the title of the volume:—§ 22, “On this hypothesis the term *Vis Inertiæ*, applied to matter, is meaningless.” Again in § 23, about the case of a horse dragging a stone, we find the assertion that when

the stone is so heavy that the horse cannot move it, this is due to weight *exclusively*; previous cases having been mentioned in which friction was allowed to have a share. We are immediately told that all this is inconsistent with the third law of motion; hence the latter also falls, along with the unfortunate *Vis Inertiæ*. In all this, at least so far as we can see, there is nothing advanced but hypothesis and assertion, not always quite concordant. Did Mr Reddie ever try to open a massive iron gate, or to deliver a large curling stone? Had the weight of either body anything to do with the difficulty he experienced in handling it? Did he ever try to stop a large grindstone set in rapid rotation, or was he ever struck by a cricket-ball? We fear he has not been, or he would reverence the recollection of the *Vis Inertiæ*. Does our instructor believe in the *mass* of the earth, or does he speak of its *weight*, and if so, how is he to determine it? Would a stone be a whit less massive if there were no earth to attract it? But we fear we are assuming the function of mentor, instead of imbibing meekly and gladly the great lesson he is teaching. And this is its moral, so far as we are able to judge:—"Learn natural philosophy from the popular scientific works of the day, *Mechanics for Schools, Hydrostatics and the Use of the Globes for her Young Friends*, by an Old Lady, &c. &c. They swarm on every counter—buy *them* and learn. Newton, Laplace, and Faraday, though clever men on the whole, came to the study of the simplicity of nature with minds biassed and distorted by untrustworthy mathematics, or the still more dangerous snares of hypothesis. Till they lay aside what has been heretofore supposed to constitute their especial fitness for the work, all that they may do or say must be erroneous." Great art thou, O Reddie! and in thee is no deceit at all.

We have not space to examine much more of the new theory. Centripetal force has been utterly misunderstood till now (§ 80). We find that we were blindly mistaken when, a few years ago, we heaped a "torrent of ridicule" on the ingenious discoverer of the moon's having no rotation about her axis (§ 77). The note to § 112 we were almost tempted to extract in full; such a mass of astounding novelty it would perhaps be difficult to find elsewhere in so small a space. But we prefer extracting, from the note to § 100, a trembling anticipation of a possible law of hydrostatics which even *we* must allow is likely to be true, though we imagine we have read it elsewhere, and fancy Archimedes had something to do with it; but we are in all probability mistaken: "If a stone be weighed with a spring-balance in water, and in air, I apprehend its normal weight would differ!!" Why the spring-balance is required Mr Reddie does not think it necessary to inform us; and we cannot gather it from the rest of his note, which, like the first mention of almost all great discoveries, is singularly obscure.

A body acted on by gravity moves in a parabola (or, as it is sometimes called (§ 106), a paraboloid). Hence it is impossible that it could move in a circle about the earth's centre (§ 105). § 144, "There is much to be said in favour of reverting to the old notion of a central earth, surrounded by its glorious canopy and hosts of revolving lights, as after all most probable." Central earth—revolving lights! Shades of Copernicus and Lighthouse Commissioners! Peace to your honoured manes; let no earthly or spiritual considerations tempt you to revisit the glimpses of the moon, for she revolves not, neither does the earth, and even the catadioptric apparatus is superseded by blinking stars. Advance, ye legions of the apostolic M'Hale, an era of superstition is again at hand; and, after all, we may find that the moon is no bigger and no rounder than a loo table.

One extract more, and we finish. § 30, "There is a great temptation to generalise still further, and assume that cold and gravitation are in their essence and ultimate principle the same!" We have recently been reperusing, for the twentieth time, a remarkably clever but disagreeable novel—one written many years ago, but still, we are happy to think, affording both pleasure and profit to a host of readers. We close with a paragraph from it, which has somewhat more than a mere resemblance to the above § 30 of Mr Reddie's treatise:—

"Researches into Physical Science, with a view to the Establishment of a New Principle, LIGHTNESS. By Diabolus Gander, Esq., Ph.D., &c. &c."

Let the candid reader make a mental comparison, and may it tend to his enlightenment, helping him to estimate at their true value the class of works of which that we have before us is a very favourable specimen.

De Candolle, Prodrromus Systematis Naturalis Regni Vegetabilis, sive Enumeratio contracta ordinum, generum, specierumque plantarum hucusque cognitarum, juxta methodi naturalis normas digesta. Editore et pro rata parte auctore ALPHONSO DE CANDOLLE. Pars decima quinto, sectio posterior. Fasc. 1, 8vo. Parisiis. Masson et Filii. Januario, 1862.

The present part of this valuable work contains descriptions by Boissier of some of the plants belonging to the natural order Euphorbiaceæ. It embraces, Tribe I, Euphorbiæ, in which the male flowers are not calyculate. Of the genus *Pedilanthus* 15 species are noticed, of the genus *Euphorbia* 723 species, and 2 species of *Synadenium*. The genus *Euphorbia* is divided into 27 sections. There is an excellent and useful index of the names and synonymes of this extensive genus. We sincerely trust that

M. Alphonse De Candolle may be spared to complete this important work, which was commenced by his illustrious father. We learn, however, that the distinguished author has no intention of entering on the Monocotyledonous orders. It may be hoped that his son Casimir, who has already published some good botanical papers, will continue the "Prodromus," with the assistance of able botanists.

De la Production Naturelle et Artificielle du Liège dans le Chêne-Liège. Par M. CASIMIR DE CANDOLLE. Genève, 1860.

The cork of commerce is derived from two species of *Quercus*. 1. *Q. occidentalis*, Gay, which grows in the south-west of France and in Portugal, and which is recognised by its acorns taking two years to ripen; 2. *Q. Suber*, which grows in the south-east of France, in Italy, and in Algeria, as well as in the islands of the Mediterranean. M. Casimir De Candolle, representing the third generation of botanists of that name, paid a visit to Algeria, and examined the development of the cork in the latter species. He has given the results of his observations in this paper. There are four layers—the epidermis, the corky layer, the cellular layer, and the liber. The development of these layers is traced through their various stages in an able manner, and the remarks are illustrated by well-executed drawings. It appears that the corky layer formed naturally has little commercial value. It is removed, and then a new corky layer is formed, which is much finer and more elastic. This constitutes the cork of commerce. At the end of seven or eight years, this layer attains sufficient thickness, and it is then removed. The author gives full details of the mode of growth of the cortical layers; he describes their microscopical structure, and points out the mode in which the best qualities of cork are produced. The essay indicates botanical acumen and powers of microscopical observation which give promise of good fruit in future years.

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 6th January 1862.—The HON. LORD NEAVES,
Vice-President, in the Chair.

An address of condolence to Her Majesty, on account of the death of his Royal Highness the Prince Consort, was adopted by the Society ; and the Secretary was directed to transmit it, after receiving the signature of the President, to Sir George Grey, Principal Secretary of State for the Home Department.

The following Communications were read :—

1. On the Climate of Palestine in Modern compared to Ancient Times. By Principal Forbes.

(This Paper appears in the present number of this Journal.)

2. Biographical Notice of Andrew Dalzel, Professor of Greek in the University of Edinburgh. By Professor Innes.

Professor Dalzel was born in 1742, at Gateside of Newliston. His father died while he was still an infant, and he was educated partly by his uncle, the minister of Stonykirk, in Galloway, and after *his* death, by his mother, at Newliston. He attended the parish school of Kirkliston, and from thence went to college at Edinburgh. His companion at both was Robert Liston, afterwards Sir Robert, the ambassador. The boys began life together. Liston was just two days younger than his friend, and the intimacy of school and college lasted through life. It is chiefly from the correspondence kept up between them from 1766 till 1805 that the present Memoir has been compiled.

On leaving college, Dalzel was for some time tutor in the family of Lauderdale, and the friendship so commenced also remained firm and unbroken through life.

In 1772–73, partly by an arrangement with his predecessor, partly through the influence of the Lauderdales with the Town Council, Dalzel became Professor of Greek in the University. The study of that language had fallen much into decay in Scotland, and Dalzel set himself zealously to the task of restoring and promoting it. He devoted himself to the duties of his class, and was soon

rewarded by its increase in numbers and improvement in study. Among other means for his object, he set about preparing some class-books for Greek students which were then unknown. His first publication was a little supplement to Moor's Grammar, under the title of *Fragmenta Grammatices Græcæ in usum tironum in literis Græcis in Academia Edinensi*. The prose volume of his well-known *Collectanea Majora* was published in 1785, and got almost at once into favour with the best teachers here and in England.

In the immediate duties of his professorship Dalzel was indefatigable. Dr Monro said of him, that "he had more to brag of than any man in the college, for that Greek was going fast downhill till he revived it." His second volume, the poetical portion of the *Collectanea Majora*, cost him great labour, and obtained the assistance of many friends among the best scholars of England. Though long promised and urgently called for by the schoolmasters and "the trade," it was not published till 1797. It was then received with as much favour as its predecessor; and the two volumes rapidly came to supersede all other class-books for Greek students. Both volumes passed through many editions, and perhaps wanted nothing for permanent success and popularity, but that the valuable information conveyed in the notes should have been given in English instead of Latin, which the practice of the time seemed to require.

Dalzel married, in 1786, Anne, daughter of Dr John Drysdale, the well known clerk of the General Assembly, and one of the leaders of the Church. His marriage connected him with the Adams, Principal Robertson, the Kennedys of Dunure, the Broughams, Elliots of Minto, and the rest of that remarkable group of Edinburgh families. His professorial position brought him into intimate acquaintance with the philosophers and scholars who then made our University famous. His labours in publishing books for his class, connected him with many distinguished scholars; and a good deal of his correspondence is preserved and used for this Memoir. It embraces letters from Heyne, Böttiger, Porson, Parr, Bishop Burgess, Dr Raine of the Charterhouse, Tate, the excellent master of Richmond school, Thomas Young, the scientific philosopher and universal scholar.

The Memoir has frequent notices of the commencement and progress of the University buildings, and other academic matters; including the first *Symposium Academicum*, the death and character of Principal Robertson, the commencement of the Society of Antiquaries, and in connection with it, the foundation of the Royal Society, of which Dalzel was an original and active member. It notices also some passing events; such as visits of remarkable persons to Edinburgh, the impression made by Burke, by Burns, by Mrs Siddons, &c.

But the chief object of the Memoir, as of Dalzel's whole life, is

the restoration of Greek and classical education in Scotland. The writer gives his reasons for preferring a classical discipline to either a purely metaphysical or a merely physical course of education, formerly and now preferred among us.

Dalzel's character was singularly amiable. Living in factious and contentious times, in a society not always peaceful, he courageously avoided all quarrels, and gave his whole energy to his duty. In society and his family he was equally fortunate and beloved; and his life is an example of happiness uninterrupted, arising from successful devotion of talents to a worthy object. Dalzel died on the 8th December 1806.

Monday, 20th January 1862.—JAMES T. GIBSON-CRAIG, Esq., Treasurer, in the Chair.

The following Communications were read :—

1. Note on the Phosphorescence of *Berœ*. By Professor Allman.

The author stated, as the results of some experiments which he had made on the phosphorescence of a species of *Berœ* (*Idyia*) which abounded during the last summer in the Firth of Forth, that the light is never emitted as long as the animal is exposed to daylight; and that withdrawal from the daylight for some time is necessary, in order to impart to the *Berœ* the property of phosphorescence.

A glass jar, containing several living specimens of the *Berœ* in sea water, was removed from the daylight into a dark room, when not the slightest indication of phosphorescence could be detected, though the animals were subjected to precisely the same kind of irritation as is found to be always followed by the emission of light during the night. But after the *Berœs* had remained for about twenty minutes in the dark, the phosphorescence had become as vivid as by night; the slightest irritation would call it forth, and the vibration communicated to the jar by a blow on the table where it lay, was sufficient to cause the emission of a vivid flash of beautiful greenish light.

The author was aware that a source of fallacy might exist in the want of sensitiveness in the experimenter to faint luminous impressions, immediately after exposure of his own eyes to ordinary daylight; and accordingly no conclusion was arrived at as to the absence of luminosity until the eye was rendered sufficiently sensitive by confinement for some time in the dark room.

The absence, then, of luminosity in these animals during the day,

is not due alone to the phosphorescence being rendered invisible by the stronger daylight, but to the fact that no light whatever is at that time emitted by the animal.

The author also stated that the embryo, while still included within the egg, is eminently phosphorescent, and that the emission of the light is subject to exactly the same conditions as in the adult. He was of opinion that the ova and free embryos of the *Berœ* and other *Ctenophora*, are among the chief sources of the phosphorescence of the sea in our latitudes—an opinion which finds support in the immense number of ova produced by these monœcious animals, taken in connection with the countless multitudes of *Ctenophora* which at certain seasons of the year crowd the seas round our coasts.

2. Contributions to our Knowledge of the Structure and Development of the *Beroidæ*. By Professor Allman.

In this communication the author gave the results of some careful observations and dissections he had made of a species of *Berœ* (*Idyia*), obtained in abundance during the last summer in the Firth of Forth.

In the anatomy of the adult animal, several points were described which seem to have been hitherto either overlooked or imperfectly examined. In the digestive system, the author noticed the presence of two richly ciliated membranous semi-elliptical flaps, which just before the stomach terminates in the narrow neck which leads into the bifurcating funnel, spring from its walls, and extend, by their free extremities, into the neck and commencement of the funnel. The equivalents of these flaps will doubtless be found in the two lips noticed by Milne Edwards in a similar position in *Berœ Forskalii*; and the author is of opinion that they are also the homologues of the two membranous appendages described by M. Edwards, in the stomach of *Lesueuria vitrea*. He also described the peculiar rod-like cilia noticed by Agassiz, as extending over the whole of the inner surface of the stomach, but which the author finds, in the specimens examined by him, to be confined to a broad band commencing just within the mouth, the remainder of the stomach walls being covered with ordinary cilia, which are very minute except on the contracted neck, where they become long and powerful. Peculiar enigmatical bodies were described as being present in the walls of the ramified cæca which spring from the meridional canals. They are in the form of minute cushion-like discs, which are prominent upon the external surface of the cæcal tubes. The disc is depressed in the centre, and from this depression a little conical elevation projects into the surrounding tissue of the animal. The cæcal tubes are also partially invested by a peculiar layer which extends over irregular spaces of their walls. This layer has been regarded as an extension of the ovary, but the author views it as an

entirely independent structure. It is composed of minute cells, and may possibly be an eliminating organ.

A highly-developed system of capillary tubes was described in detail, as constituting one of the most interesting features in the structure of *Beröe*. These tubes seem to have been noticed by Gegenbaur,* who describes a network formed by the anastomosing offsets of cells, and which, in very young individuals, represents a system of repeatedly anastomosing tubes. They seem to constitute the same structure as that which Agassiz at one time† described as muscular fibres in *Cydippe*—an opinion, however, which he subsequently retracts, preferring, in his latest works,‡ to regard them as merely the optical expression of the walls of very large cells. The author has no hesitation in maintaining that these are all delicate capillary tubes, but without true anastomosis. They are divisible into four sets, differing from one another in their deeper or more superficial position, and in the general direction of their course. He believes that they may be conveniently divided into the following sets :—

- | | | |
|--------------------------|--|---------------------|
| 1. Longitudinal. | \| | 3. Deep circular. |
| 2. Superficial circular. | \| | 4. Gastro-parietal. |

In the gastro-parietal set, especially, which extend from the walls of the stomach towards the external surface of the body, he had no difficulty in demonstrating a true tubular structure. Under stimulation they contract longitudinally, and become thickened transversely; and then they are plainly seen to be thick-walled tubes whose cavity encloses a granular matter. The tubules composing the other three sets seem to be also contractile, though this property is not so apparent in them as in the gastro-parietal set. All the four sets depolarise light, and present a similar appearance under the polariscope.

To the two oval ciliated spaces, situated one at either side of the ocellus, the author gave the name of tentacular discs. The margin of each disc is marked by a double line, on whose interval is borne a series of short hollow tentacular processes, simple in young specimens, but irregularly lobed or ramified in adults, covered over their whole surface with fine actively-vibrating cilia, and containing numerous pigment cells in their walls. The double line marks the boundary of a canal which runs round the disc upon its deep surface, and into which the bases of the tentacles open, the canal ceasing to be continuous at the inner extremity of the major axis of the disc, where there is a short space destitute of tentacles. The author maintains that the cavity of the tentacles, and their common basal canal,

* Studien über Organisation und systematik der Ctenophoren. Wiegmann's Archiv, 1856.

† On the Beroid Medusæ of the Shores of Massachusetts. 1860.

‡ Contributions to the Natural History of the United States of America. Vol. III. 1860.

communicate, through the bifurcations of the funnel, with the general gastro-vascular system.

Eight chord-like organs have been noticed by observers, and have been described in detail by Agassiz as extending from beneath the ocelliform body to the extremities of the eight meridional bands; but the fact has not been hitherto noticed, that where they lie upon the cushion-like body which supports the sense capsule, they coalesce two and two, so as here to be but four in number. These four chords are clothed with true vibratile cilia. The author also described two additional chords, which originate also beneath the ocellus, one at each side, exactly opposite to the tentacular discs, and thence running outwards without dividing, lose themselves in the discs. These, like the former, are clothed with vibratile cilia. The true origin of the chords he believes to be in a ganglion-like tubercle which lies immediately under the sense capsule, and between it and the cushion-like body. Contrary to the opinion of Agassiz, the author regards these chords as truly representing a nervous system.

The author described four spherical tubercles, situated two upon each side of the cushion-like body, and between it and the tentacular discs. These are the equivalents of exactly similar tubercles described by Agassiz in *Cydidpe*, but not noticed by him in his description of *Idyia*.

Development.

In his account of the development of *Beröe*, the author described the ovum, after its escape from the surrounding water, as consisting of a spherical vitellus, surrounded by an external transparent and structureless shell, which is separated by a wide interval from the vitellus, the whole being at this time generally surrounded by an atmosphere of spermatozoa, which are in the form of very minute caudate corpuscles.

No trace of germinal vesicle or spot could be detected in the vitellus, which has the appearance of being composed of minute cells, and whose peripheral portion is differentiated as a somewhat denser layer. A few hours after the escape of the ovum segmentation begins, and this process goes on until the vitellus is broken up into numerous very distinct and quite free spherules, each of which is plainly a cell filled with a multitude of similar cells. The segmenting process, however, has not been going on uniformly in all the divisions, and these resulting spherules are consequently of unequal size, and represent different stages in the process. Next, successive segmentations go on with great activity in some of the spherules, while others continue unaffected by it, or present it with much less energy, and the former become broken up into a multitude of cells, by which the latter are gradually enveloped; so that the ovum now presents two very distinct portions—a central one composed of large spherical cells, and a peripheral one of much smaller cells.

Simultaneously with the completion of the peripheral layer, a large lacuna is formed among the cells in the centre of the ovum. A depression—the future mouth—next takes place upon the surface of the embryo; and this becomes deeper and deeper, until it reaches the central lacuna, into which it finally opens. At the same time, the ocelliform body, with its capsule, and the rudiments of the tentacular discs, become apparent. The refractile corpuscles of which the ocelliform body is composed, may at this time be plainly seen to be developed in the interior of delicate spherical cells. The eight meridional bands have also by this time made their appearance, and may be seen in four pairs extending from within a short distance of the ocellus, along the sides of the embryo to about one-fourth of the whole distance from the ocellus to the mouth.

The next stage observed is the differentiation of a portion of the large-celled tissue which constitutes the principal substance of the embryo, into two somewhat piriform masses, extending one on either side of the alimentary cavity, and which, simultaneously with their formation, become excavated by an extension of the large central lacuna. They thus form two large sacs appended to the central lacuna, and opening into it, and are to become the deep longitudinal gastro-vascular canals.

Nearly at the same time, two other exactly similar masses, and also containing an extension of the central lacuna, are found opposite to one another, on the two remaining sides of the alimentary cavity, so that this cavity is now surrounded by four sacs.

The two last-formed sacs now become divided, each into two, and the divisions thus produced become more and more widely separated from one another, and become superficial to the first formed sacs. We now find them in contact with the peripheral layer of the embryo, where each sac corresponds to the space occupied by a pair of meridional bands and the interval between them.

Lastly, These four sacs begin to divide, each into two, from the peripheral towards the central side, leaving one half adhering by its peripheral side to each meridional band, so that every band has now a sac to itself, and the subsequent conversion of these sacs into the eight meridional canals is easily understood.

About the same time the central lacuna has sent off its two branches, which are to open by external orifices at each side of the ocelliform body; but the author had not succeeded in satisfactorily tracing the formation of these branches.

Hitherto the embryo was confined within the shell, but in the next stage described, the young *Berœ* was free. It was about one-eighth of an inch in length; the meridional bands had extended to somewhat more than half the distance between the ocellus and the mouth. The mouth was surrounded by the circular canal, and the two deep gastro-vascular canals had opened into the latter. The circular canal probably originates in lateral branches from the distal

extremity of the deep gastro-vascular canal; but the author failed in satisfactorily tracing its mode of development. Four out of the eight superficial gastro-vascular or ctenophoral canals, namely those which corresponded to the narrow sides of the digestive cavity, had also opened into the circular canal; but the other four meridional canals, though extending for some distance beyond the oral extremities of the meridional bands, had not yet opened into it, and terminated towards the mouth, each in a blind extremity. The eight meridional canals had begun to send out their cæcal offsets; but these were as yet few in number, and simple. Individuals of about three-fourths of an inch in length had all the gastro-vascular canals in communication with the circular canal. The cæca had become numerous and ramified, and the capillary tubes appeared fully developed. The meridional bands, however, had not yet attained their full extent, their oral termination being still separated from the mouth by a distance equal to about one-third of the entire meridional length of the animal; while the generative organs had not yet made their appearance, and the processes of the tentacular discs were nearly simple.

3. On the Anatomy and Classification of the Heteropoda. By John Denis Macdonald, Esq., R.N., F.R.S., Surgeon of H.M.S. "Icarus." Communicated by Dr Douglas MacLagan.

The author considers the usual division of the Heteropoda into the two families *Firolidæ*, and *Atlantidæ* as unsatisfactory, and arranges them in three families, according to the following zoological characters.

HETEROPODA.

I. GYMNOSOMATA (*Firolidæ*). Animal wholly naked or without a shell.

1. With slender tentacula, and destitute of true branchiæ. Visceral mass near the root of the filiform process of the Metapodium—*Firoloides*.
2. With rudimentary or no tentacula, but furnished with true branchiæ. Visceral mass considerably in advance of the base of the filiform process of the Metapodium—*Firola*.

II. THECOSOMATA INOPERCULATA (*Carinariidæ*). Animal in great part naked, but having the visceral mass protected by a shell.

1. Shell corneous, with an involute nucleus. Swimming-plate nearly opposite the visceral mass. Metapodium with filiform appendage—*Cardiapoda*.
2. Shell calcareous with spiral nucleus. Swimming-plate considerably in advance of the visceral mass. Metapodium laterally compressed without filiform appendage—*Carinaria*.

III. THYRSOMATA OPERCULATA (*Atlantida*.)

1. Shell corneous with an involute nucleus. Operculum subtrigonal, with small lateral subapical nucleus—*Oxygyrus*.
2. Shell calcareous with a spiral nucleus. Operculum oval, with a large median subapical nucleus—*Atlanta*.

After describing the several characters of the order as regards external configuration, eyes, and auditory sacs, the author called attention to the rachidian teeth as being capable of furnishing good generic characters, for which they are especially valuable, as they often outlive the decay of the soft parts.

To avoid undue extension of his paper, the author selected for special description the genera *Firoloides* and *Atlanta*, which occupy, according to his views, the two extremes of the group; and he described in detail, and illustrated by coloured drawings, the anatomy of a species of *Firoloides* which he had met with in Bass's Strait, and the anatomy of *Atlanta*, with reference to all the species of the genus, adding to these some observations on the other genera, and deferring questions of specific determination to a future paper.

4. On the Structure of *Chondracanthus Lophii*; with Observations on its Larval Form. By William Turner, M.B., and H. S. Wilson, M.D., Demonstrators of Anatomy.

The authors, after a brief historical introduction, proceeded to give a detailed account of the anatomy of this parasitic crustacean, the description comprising that of the female and male, and, so far as they had been enabled to trace it, of the larva also.

FEMALE.—Average length, $\frac{1}{2}$ inch; breadth, $\frac{1}{4}$ th inch—divided into cephalic, thoracic, and abdominal portions. Cephalic part presented on each side a lateral process; at the anterior margin a pair of antennæ; and on the ventral aspect a pair of hook organs and three pairs of foot-jaws. The antennæ were segmented, the terminal segments being provided with hairs. Each hook organ consisted of a basal segment and a terminal hook; the former of which was supported on a well-marked triangular frame, on which it was moved by the action of powerful muscles. The foot-jaws, attached a little on one side of the mesial line, consisted of three pairs. The first and second foot-jaws consisted each of two segments. The terminal segment in the first foot-jaw was formed of two chitinic plates, connected by their anterior margins, but separated at their posterior margins, which were armed with teeth. The corresponding segment in the second foot-jaw consisted of but a single plate, toothed along its posterior margin. The third foot-jaw had three segments, the terminal one being destitute of teeth.

The cephalic was separated from the thoracic part by a constricted neck.

The thoracic part was characterised by its processes, seven dorsal,

two ventral, and five lateral, the cavities within which communicated with the general cavity of the thorax. Its division into four segments was indicated by constrictions. The first and second segments bore each a pair of feet on their ventral aspects.

The abdominal part, very small, was divided into two segments, the anterior of which presented a pair of nipple-like projections, to one of which the male was attached. Of these the authors gave a minute description. Two genital orifices opened, one on each side of this segment. From each orifice a long string of ova, spirally twisted, depended. The ovaries consisted of a branched system of tubes, occupying the cavity of the thorax, and extending into the processes and feet. Each ovary communicated close to the genital orifice with the cement organ. The alimentary canal, axially situated, commenced at the oral aperture, which was situated immediately in front of the first pair of foot-jaws. It reached almost as far as the thoracic end of the animal. It possessed lateral dilations, but no anus.

MALE, very minute, $\frac{1}{10}$ th of an inch in length, pyriform in shape. Divided into cephalic, thoracic, and abdominal parts—cephalic end broadest and largest; furnished with antennæ, hook organs, and foot-jaws. By its hook organs it was attached to one of the nipple-like projections on the body of the female, on which it was parasitic. Hook organs and foot-jaws resembling in miniature those of the female. Thoracic part distinctly divided into four segments, the two anterior bearing each a pair of feet. No dorsal, ventral, or lateral processes. Abdominal part divided into two segments, in the proximal of which the two male genital orifices were situated. Alimentary canal in the axis of the animal, with a mouth situated as in the female, but no anus. Testicles bilateral.

Various stages in the development of the ovum, as far as the formation of a free larva, were then described; but the further stages, up to the fully developed animal, the author had no opportunity of tracing.

Monday, 3d February 1862.—DR CHRISTISON, V.P.,
in the Chair.

The following Communications were read:—

1. Investigation of an Expression for the Mean Temperature of a Stratum of Soil, in terms of the time of year. By J. D. Everett, M.A., Prof. of Mathematics, &c. in King's College, Windsor, Nova Scotia. Communicated by Prof. Tait.

In vol. xxii. of the Transactions of the Society, Prof. W. Thomson has given (after Fourier) the general solution of the problem of

underground conduction, and he and Professor Everett have given methods more or less accurate of determining from observation the specific constants for any locality. These are mainly applied to the results of Principal Forbes's observations on the Calton Hill and other places near Edinburgh. (*Trans.*, vol. xvi.)

The present paper has for its object the calculation of the mean temperature of a given stratum of soil at any given time. If v be the temperature at time t , at depth x , v is known by the paper first referred to, in terms of x and t —and the object of the present paper is the easy approximate calculation of the value of the quantity $\frac{\int v dx}{\int dx}$ between any limits of depth x . The method is applied to the Calton Hill observations.

2. Notice of the Catadioptric Altitude and Azimuth Circle.

By Edward Sang, Esq.*

This little instrument differs from the ordinary theodolite in the means by which the direction of the object under examination is indicated.

The simplest contrivance for marking the direction of a distant object is a straight rod. This, with the very obvious improvement of studs at the ends, was the only instrument available to the ancients for astronomical observations; it is yet employed in gunnery, and even by surveyors in the plain-table and cross-staff.

The objection to the plain-sight, when it is to be applied to accurate purposes, is that the eye cannot be adapted to distinct vision for three different distances at the same time. We cannot see the notch, the *visé*, and the object aimed at, all distinctly.

The invention of the telescope effected a complete change in the apparatus for the precise measurement of angles. By it the arrangement of the plain-sight was reversed; the eye-hole was expanded to admit the object-glass, and the image was received at the plane of the cross-wires.

These two are the only improvements which have hitherto been made in the art of pointing. Hadley's quadrant, the invention of which has almost created nautical astronomy, is a contrivance for indicating the difference between the directions of two objects; it does not show the direction of either.

The pointer used in the catadioptric theodolite is thus the third of its class; it contains, literally within the compass of a nut-shell, the means of determining the direction of an object true to within half a minute of a degree.

About the years 1815, 1816, the late Rev. Edward Irving gave to his class of young geometers as an exercise, "To construct graduated squares with plummets attached, by help of which the tangents of angles of elevation may be observed." Some of us used

pasteboard, some wood; and it happened that, having broken my school slate, which was a thick one, the idea came into my head to make my square out of the larger fragment. Armed with these little instruments, we attacked and carried most of the surrounding heights. The weather-cock on the top of the church steeple was, as a matter of course, one of our targets. On bringing the upper edge of my slate-square to bear upon it, that upper edge having been ground flat and pretty well smoothed, I saw the inverted image of the weather-cock. It then occurred to me that, if I could bring the image to agree with the weather-cock itself, the plane of the upper edge would be accurately pointed. At the same time it was obvious that when the plane passed through the object there could be no reflection.

Here, then, was a problem "To obtain a reflection such that the reflected can be collated with the direct image, and afford a test of accurate pointing." The pointer used in the catadioptric theodolite exhibits a complete solution of this problem. It is a piece of glass cut in the form of an isosceles tetrahedron, of which two faces form an edge of about 90° , the other two an edge of about 126° , the one pair being set symmetrically upon the other. This pointer has been patented. On turning it towards any object, and looking into the glass, we perceive an inverted image of the object, and on bringing the eye to look past the edge of the glass, as when using the *camera lucida*, we see the object also; and so can collate the image with the object.

By means of the motions in altitude and azimuth we can cause the image to agree with the object, and are then certain that the line of direction passes through the object.

I do not wish to occupy the time of the Society with a disquisition on the theory of the pointer, but rather to indicate the peculiar facilities which it gives for astronomical and geodetical operations in which a precision to half a minute is sufficient. The instrument is inapplicable whenever greater nicety than this is requisite.

When we point the telescope of a common surveying theodolite to a star, we find that the cross-wires have disappeared in the darkness, and that it is necessary to render the wires visible by making an artificial twilight within the tube. To hold the lamp for this purpose is so troublesome, unless—as in the case of large instruments—a special arrangement be made, that very few surveyors indeed ever use their theodolites for sidereal observations.

But, by using the crystal pointer, the star itself is made the point of reference, and the illuminating apparatus is unneeded.

If we bring the catadioptric theodolite into such a position as to cause the image of a star to agree with the star seen directly, and leave the instrument untouched, the two bright points are seen slowly to separate; while the star moves forward in its diurnal circuit the image moves with the same velocity backwards, the rate

of separation is doubled, and the line joining the two points indicates the direction of the motion. In this way it is easy to determine whether the star be ascending or descending, or to judge of its being at its greatest or least altitude. Thus the determination of the latitude from the meridian altitude of a star is very easy; that of the sidereal time is not less so.

We have to note the exact instant at which some star, not far from the prime vertical, has a known altitude. For this purpose we turn the pointer a little in advance of the star, and bring the image to be very nearly above or below the star, according as the observation is made on the east or on the west side of the meridian. Then, counting the beats of the chronometer, we watch until the line joining the two become horizontal, and thus obtain the instant at which the star had the elevation shown on the altitude circle.

It is better, when making this observation for time alone, to let the image pass at a little distance—say two or three minutes—from the star, than to attempt to make them coincide, because the eye can very readily judge of the horizontality of the line joining the two luminous points. But the altitude azimuth and time can all be obtained at once in the following way:—

Having brought about the coincidence, we watch for one or two minutes, and estimate carefully the direction of the separation, then, by help of the tangent-screws, we cause the image and the star to exchange places, as it were, keeping the same inclination, and leaving the instrument untouched, we count the beats of the chronometer until the coincidence take place. In this way we obtain the time and the simultaneous readings on the altitude and azimuth circles; from these the longitude and the direction of the meridian can be computed.

The direction of the meridian is very readily obtained from the greatest easting or westing of a star which passes between the pole and the zenith, particularly in low latitudes. The manner of proceeding with the crystal pointer is to make the coincidence, to wait a little and observe the direction of separation; when this direction is vertical the star is at its greatest azimuth.

Lastly, the latitude of the place may be corrected by observing the two transits of a star over the prime vertical near to the zenith; the operation is exactly analogous to those already described.

When the horizontal axis is made perpendicular to the meridian the instrument can be used as a transit. The instant of the sun's passage can be found by observing the contact of the first limb, then the entire coincidence, and lastly, the contact of the second limb. The average of these three may, in general, be depended upon to within two seconds of time; while, by observing the moon's meridian passage, and comparing it with those of two stars, the Greenwich time may be obtained to within one minute from a single set of observations.

The lightness and portability of the instrument, and its adaptation to near or distant objects, promise to bring the practice of geodetical astronomy within the reach of many who have been hindered from the prosecution of this branch of science by the bulk and expensiveness of the instruments required.

3. On the Nesting Birds of Linlithgowshire and Berwickshire. By the Rev. John Duns, F.R.S.E., Torphichen.

In April 1860, I brought under the notice of the Society a classified list of the Birds of Linlithgowshire. The list was accompanied with notes, "On the Structure and Habits of some of the Rarer Species." After the publication of the Society's Proceedings, several communications were addressed to me by well-known ornithologists, chiefly with the view of ascertaining, if some of the rarer species named had been known to nest in the district. This led to the revision of the list, and to the exclusion of such species as are either rare visitors only, or winter birds of passage. A List of the Birds of Berwickshire, drawn up on the same plan, is now associated with this.

Were similar lists to be drawn up by observers in other counties, the true native birds of Scotland would be better known than they are at present. In most works on British Ornithology they are classed with stragglers from almost every clime.

Several influences are at work, which may soon come to diminish the numbers of our native nesting-birds, and which have already reduced them in certain districts. In the Lowlands, there are now large tracts of country, in which game is not protected, and in which laws of trespass are never enforced. It is thus easy for any youth to carry a gun in quarters in which, a few years ago, he would have been closely watched. The rarer birds suffer; they are intruded on in their favourite haunts, and either scared from them at the breeding season, or wantonly destroyed. The black grouse, which used to breed regularly in Linlithgowshire, is now seldom seen, and the red grouse is now confined to a heath-clad tract, of a few hundred acres, which is being fast broken in upon by mining operations. In the course of four or five years, both species will cease to be reckoned as nesting-birds in the county. The king-fisher, the ring-ousel, the redstart, the gold-crest wren, the bullfinch and goldfinch, have so greatly diminished within a few years, that they are now comparatively rare.

The strict preservation of game has had an influence in another direction. War is waged against every bird believed to be hurtful to the eggs or to the young of the pheasant, partridge, and grouse. The kite has disappeared from the middle and south of Scotland. In Berwickshire, the hen harrier is now rare; and in Linlithgowshire it appears at long intervals as a straggler only. The merlin will

soon cease to be met with in both counties. The sparrow-hawk is fast disappearing; and even the kestrel—the farmer's friend against field mice, and several beetles, whose larvæ are most hurtful to his wheat crops—is ignorantly shot down as a plunderer, though entirely innocent touching game. In comparatively recent times, the raven used to nest in Linlithgowshire. It is now never seen. In Berwickshire, it is rare. In Linlithgowshire, the jay is seldom met with, and even the magpie is not able to cope in cunning with the game-keeper.

Agricultural improvements are also beginning to tell unfavourably on some of our native birds. If the alternative were,—“ You must either lose the green and corn crops, or destroy the birds,” I suppose even the most enthusiastic naturalist would choose the latter. But it should be the chief aim of the agriculturist to keep the birds alongside of his improvements. Since by drainage, he has banished the wild duck, the curlew, and the snipe, from localities in which they used to abound, he would find it profitable to set apart a spot specially for them. And if he must have stone walls and wire fences, in order to get quit of weeds and to save his crops from insects which find shelter during winter in the hedge-rows, he would never regret having left a bush here and there for the birds to build in. If this be not done, he will assuredly find in the turnip-beetles and saw-flies, in the corn-midges and wire-worms—the larvæ of weevils and elaters—“ a great people and strong,” enemies, any thousand of which will do more harm to his crops than all the birds of the air would.

In the following list the birds of Linlithgowshire are referred to on the left hand of the column. Those of Berwickshire are characterised on the right hand.

The letter R denotes *Regular*, or birds which breed constantly in the districts; H denotes *Historical*, or birds which used to breed in the localities, but which have for many years ceased to do so; O denotes *Occasional*, or birds which have been known to breed at long intervals in the districts; and O, B refers to such as have been seen occasionally at the breeding season, but whose nests have not been discovered.

Linlithgowshire.	Berwickshire.	Linlithgowshire.	Berwickshire.
O. Falco aesalon.	O.	R. Hirundo riparia.	R.
R. F. tinnunculus.	R.	R. Cypselus murarius.	R.
R. Accipiter nisus.	R.	O. Alcedo ispida.	R.
H. Circus cyaneus.	R.	R. Certhia familiaris.	R.
R. Strix flammea.	R.	R. Troglodytes Europæus.	R.
R. S. aluco.	R.	R. Turdus merula.	R.
R. S. otus.	R.	O. T. torquatus.	R.
R. Cuculus canorus.	R.	R. T. viscivorus.	R.
R. Caprimulgus Europæus.	R.	R. T. musicus.	R.
R. Hirundo rustica.	R.	R. Cinclus Europæus.	R.
R. H. urbana.	R.	O.B. Lanius excubitor.	

Linlithgowshire.	Berwickshire.	Linlithgowshire.	Berwickshire.
Lanius collurio.	O. B.	R. Columba palumbus.	R.
R. Sylvia rubecula.	R.	C. livia.	R.
R. S. hortensis.	R.	O. Tetrao Scoticus.	R.
S. atricapilla.	O.	O. T. tetrix.	R.
R. S. cinerea.	R.	R. Perdix cinerea.	R.
R. S. phoenicurus.	R.	O. P. coturnix.	R.
O. S. locustella.		R. Phasianus colchicus.	R.
O. S. arundinacea.	O.	R. Ardea cinerea.	R.
O. Phyllopneuste sylvicola.	R.	H. Botaurus stellaris.	R.
R. Ph. trochilus.	R.	R. Charadrius hiaticula.	R.
O. Ph. hippolais.	R.	R. Pluvialis aurea.	R.
R. Regulus auricapillus.	R.	P. morinellus.	O. B.
R. Saxicola cinerula.	R.	Hæmatopus ostralogus.	R.
R. S. rubetra.	R.	O. B. Scolopax rusticola.	
R. S. rubicola.	R.	R. S. gallinago.	R.
R. Accentor modularis.	R.	O. B. S. gallinula.	
R. Parus cæruleus.	R.	R. Numenius arquata.	R.
R. P. major.	R.	R. Totanus hypoleucus.	R.
R. P. longicaudatus.	R.	T. calidris.	R.
R. P. ater.	R.	O. Tringa variabilis.	R.
R. Motacilla Yarrelli.	R.	O. Rallus aquaticus.	R.
R. M. boarula.	R.	R. Crex pratensis.	R.
R. M. flava (<i>Budytes</i> .)	R.	R. Gallinula chloropus.	R.
R. Muscicapa grisola.	R.	R. Fulica atra.	R.
O. M. luctuosa.		R. Cygnus mansuetus.	R.
H. Corvus corax.	O.	R. Anas domesticus.	R.
O. C. corone.	R.	R. A. boschas.	R.
R. C. cornix.	R.	O. B. A. crecca.	O.
R. C. frugilegus.	R.	Anas tadorna.	O.
R. C. monedula.	R.	O. Podiceps minor.	R.
R. Garrulus melanoleuca.	R.	Uria troile.	R.
R. G. glandarius.	R.	U. grylle.	R.
R. Sturnus vulgaris.	R.	Alca torda.	R.
R. Pyrgita domestica.	R.	A. artica.	R.
R. Fringilla cælebs.	R.	Pelecanus carbo.	R.
O. F. spinus.		P. graculus.	R.
R. F. carduelis.	R.	P. bassanus.	O.
R. F. cannabina.	R.	Puffinus anglorum.	O.
O. F. linaria.	R.	Procellaria pelagica.	O.
F. flavirostris.	O.	Larus rissa.	R.
R. Loxia chloris.	R.	L. marinus.	O.
R. L. pyrrhula.	R.	L. fuscus.	O.
O. L. Europæa.		L. argentatus.	R.
R. Emberiza citrinella.	R.	L. canus.	R.
O. E. miliaria.	R.	L. ridibundus.	R.
R. E. shoeniculus.	R.	Sterna cantiaca.	R.
R. Alauda arvensis.	R.	O. S. hirundo.	R.
R. Anthus pratensis.	R.	S. artica.	R.
A. obscurus.	R.	S. minuta.	R.
O. A. arboreus.	O.	S. Dougallii.	O.

A pair of the grey shrikes named in the list, frequented some old thorn trees, near Torphichen village, during the end of May and beginning of June 1846.

The red-backed shrikes were observed by me in July 1859, at Oxendean, near Dunse Castle, Berwickshire. This, I believe, was the first time they have been seen in Scotland. The red-backed shrike passes the winter in Africa, and visits England in May. "It breeds," says Fleming, "in the southern counties of England." "It is," says the late Bishop of Norwich, "generally speaking, very rare in most parts, confining itself to Essex, the Sussex Downs, Wiltshire, and Gloucestershire." Mr Selby has not traced it farther north than Cumberland. M. E. T. Bennet, in one of his notes to White's Selborne, refers to this bird as one which belongs to the south of England, and is scarcely ever met with in the north. In 1840, Mr McGillivray recorded that "it had not hitherto been observed in Scotland."

4. Note on Molecular Arrangement in Crystals. By Professor Tait.

To illustrate my lectures on Molecular Forces, I sometimes use piles of marbles of equal size. Each of these is taken to represent the *sphere of action* of a symmetrical integrant molecule, in the sense that the attractive and repulsive forces necessary to a theory of molecules are balanced, when the distance of two molecules is equal to the diameter of the sphere. If the integrant molecules be not symmetrical, their *spheres of action* will be spheroids or ellipsoids.

In arranging such piles, there are two obvious ways of constructing the layers, and two of applying layer to layer.

Thus, a horizontal layer (suppose) may be arranged in *square*, or in *triangular* order; and successive layers may be *simply superposed* or *inserted into interstices* in the preceding ones.

By this it would appear, at first sight, that arrangements of four different densities are producible. Such, however, is not the case. The very obvious results which I intend now to give, must have occurred long ago to others, but I have found no such record; and their apparent novelty to scientific friends to whom I have mentioned them, must be my excuse for occupying the time of the Society with so trifling a matter.

The density of a mass, or the number of marbles per cubic mile (say) is easily seen to be proportional inversely to the product of the distances of the centres of contiguous ones, taken parallel to any three rectangular lines.

Hence

(1.) When layers in square order are superposed, a being the radius of a molecule—

$$\text{Density} \propto \frac{1}{2a \times 2a \times 2a} \propto \frac{1}{8a^3}$$

(2.) Layers in triangular order superposed—

$$\text{Density} \propto \frac{1}{2a \times 2a \times \sqrt{3}a} \propto \frac{1}{4\sqrt{3}a^3}.$$

(3.) Layers in square order, interstices occupied by molecules of next layer—

$$\text{Density} \propto \frac{1}{2a \times 2a \times \sqrt{2}a} \propto \frac{1}{4\sqrt{2}a^3}.$$

(4.) Layers in triangular order, interstices as before,—

$$\text{Density} \propto \frac{1}{2a \times \sqrt{3}a \times \frac{2\sqrt{2}a}{\sqrt{3}}} \propto \frac{1}{4\sqrt{2}a^3}.$$

These densities are (1.) : (2.) : (3.) : (4.) :: $\frac{1}{\sqrt{2}}$: $\sqrt{\frac{2}{3}}$: 1 : 1 ;

or, 707 : 816 : 1 : 1, and may be sought for in various forms of the same body.

Hence, the density in arrangements (3) and (4) is the same. It is worthy of note, that the simplest crystalline form which is derivable from (3), is the octahedron of the first system, and that from (4), is its *hemihedral* form, the regular tetrahedron.

By inspecting the piles of marbles for the two cases, it is easy to see without analysis, that the densities are equal. This is best seen by removing an *edge* of the tetrahedral pile.

I have tried to connect these results with allotropic forms of bodies which crystallize in the first system (and an easy modification allows us to pass to other systems)—but though diamond and graphite seem to agree so far with it—it must be taken at present as a pure speculation.

Royal Physical Society.

Wednesday, 22d January.—JAMES M'BAIN, M.D., R.N., President, in the Chair.

The following Communications were read :—

1. *Notes on the Habits of the Beaver.* By an Eye-witness, JAMES M'KENZIE, Esq., an Officer in the Hudson's Bay Company Service.

The Beaver is found over a wide extent of country on the American continent, extending east and west from the Atlantic to the Pacific, and probably from Lat. 48° to 54° north ; but on the slopes of the Rocky Mountains, where the climate is comparatively mild, he is met with much further north and south. My object, however, is not so much to define his geographical limits, as to make a few notes on his habits. Beavers build occasionally on the shores of lakes, but prefer the banks of rivers and streams. They go generally in pairs ; and having selected a convenient site near the banks of the river, the two clear a circular piece of ground,

generally 6 feet in diameter, carefully removing everything on the surface. This done, they carry in their *arms*, walking on the hind feet, 5 to 10 lbs. of strong clay from the river, and deposit it to a width of 2 feet all round the circle, thus making the diameter 4 feet; then collecting long grass or branches of willow, they mix up the whole well together, so as to form a good foundation. In this way they build the walls to a height of about 10 feet, gradually narrowing; and the whole has a rounded form, somewhat like an oven. Unless they had some means of plastering or smoothing down the mud walls, the rain would certainly wear them away in a short time; and although it is supposed that the beaver never uses his tail as a trowel, I have it from the authority of eye-witnesses that he does so—in fact, Nature has furnished the animal with the tool ready made to his hand. After he has laid the foundation, and, indeed, in process of laying it, before the clay gets dry, he uses the trowel; and when the wall is raised to a certain height, he goes round the circle, carefully plastering every load he carries from the river and lays on his house. The lodge has neither doors nor windows, and the finishing hand is not put to it till he is far advanced with his bridge, or perhaps until he has completed it. Before the house can be completed, a subterranean passage is excavated from its centre to the dam or pond, and this at a depth varying from 2 to 6 feet, depending on the difference of level between the river and house. He then strews his floor with thin strips of willow tree, cut by him in the form of carpenter's shavings, for his winter's bed. The construction of the bridge shows even more ingenuity than the construction of the house, and is of various lengths, depending on the size of the stream. When only a few feet wide, the wall goes straight from bank to bank at right angles to the current; when larger, or about 40 feet wide, it is formed of a single curve; but when the river to be bridged is from 100 to 120 feet wide, the wall is formed into a series of curves, or undulations as it were. He understands pretty well the properties of straight and curved lines in his engineering works, and knows the mode best suited to the circumstances in which he is placed. If his domicile is situated on a wide stream, he adopts that mode of construction which is best adapted to withstand the pressure of a great body of water and ice on the opening of the navigation in the spring. The wall is about 12 feet high and 9 feet wide at bottom, but on the side exposed to the current it slopes with the stream, forming, perhaps, an angle of about 40°. At any rate, while the wall is about 9 feet wide at bottom, it is only 1 foot wide at top. He selects for the foundation pieces or logs of timber which are water-soaked; but if he cannot find enough of these, any wood, either green or dry, will do, covering them with large stones, to prevent their rising to the surface. But logs thus placed on one another across a stream could not be so well fitted together as to prevent the passage of the water between them. To meet this difficulty, he plasters the side of the wall exposed to the current with a coating of clay some 2 or 3 inches in thickness; and this clay, as he has to travel through the water with it, he carries not in his arms, as in the construction of the house, but on his *head*, supported by his arms. There is no doubt that the side of the wall exposed to the current is thus clayed, although I cannot well understand how it could withstand the action of the water for any length of time. If he bridged the stream in this way and clayed his bridge, it is clear that he would have always a large quantity of water flowing over the top, which would impede his operations; and, to obviate this difficulty, he leaves an opening at either end for the passage of the water, to be shut up afterwards. Having finished the wall, the next thing to be done is to collect his winter's supply of food. This consists of the bark of the ash, the bark and leaves of a certain kind of poplar, the bark and leaves of some kind of willows, and the fruit of the

alder. A large poplar tree of about a foot in diameter, two beavers can cut down in half an hour's time. It is afterwards cut into lengths of about 5 feet; and when he has got enough, he makes a road to the stream from 3 to 6 feet wide, by cutting down trees or shrubs which may be in his way. If the road be inclined towards the stream, he rolls the wood down before him; but if it be level, or nearly so, he takes hold of the wood by his teeth, and carries it forward. In the water he always transports wood or branches from one spot to another in a similar manner. His wood will, of course, float in the water, and, if left to float, would soon become embedded in the ice, which in ordinary winters, in this climate, is about 5 feet in thickness; he therefore takes it to the bottom of the dam, which has a depth of water of from 10 to 12 feet, and either fastens it on end in the mud, or covers it with stones, to prevent its rising, and it will thus at all times be available for his purpose. He is now nearly ready for the long winter. There is, however, something more to be done. I have mentioned that he digs a subterranean passage from his house to his dam; on each side of this, and in some instances widely apart, he makes holes about 5 or 6 feet in the bank, generally communicating in the interior with one another, and with the main entrance to the lodge. In one of these he takes his food, for he seldom or never eats where he sleeps.

The female has generally from three to six young at one time; the period of gestation is four months; and the young are produced, or first see the light, about the middle of May, and in the following August assist in building the lodge. The young and old work together. When about a year old, they start in pairs to form new settlements, provided, like the best of colonists for a new country, with nothing else but good strong limbs and a fine set of teeth. If there be an odd-fellow, he goes on his travels alone, and forms a small bachelor establishment for himself for the winter, unless, indeed, he meets a friend with kindred sentiments by the way. Sometimes two of the year-olds remain in the old house for another year, in which case the family in the following May is a large one, never, however, numbering more than twelve individuals. The usual number found in a lodge is from four to eight. They never build their lodges close together—they are generally from a quarter to half a mile apart. This no doubt arises from the circumstances that they cannot well dam the rivers or streams, and find a sufficiency of food, at shorter distances. The beaver remains shut up for the whole winter; during the day always asleep, and during the night taking his bath and his meals. In spring, however, he sometimes makes a hole in the ice to have a look at the country around him. I do not know how he manages to do without air; so far as I could discover, there are no air-holes about his premises. In the coldest weather, the top or roof of the lodge is always moist or wet, while the sides are frozen, at least outwardly. It is certain that he can remain under the water for half an hour at a time. He lives in the same lodge for two or four years, when, finding his food scarce, he removes to another locality and builds as before.

For instinct or intelligence he is at the head of the wild animals in this country, and lives longer, I believe, than any of them. Other animals, as for instance the young of the American hair or rabbit, the marten and lynx, perish by thousands in the spring, either by cold, or in seasons of high water, or from lack of their ordinary food; but it is all the same to the beaver whether the season be wet or dry, hot or cold—the shores of every lake and the banks of every river furnish him with abundance of food.

I do not know whether he will thrive in Britain; at any rate, the Zoological Gardens is not the best place for him; he is fond of solitude, and does not like company. An island with a large lake would be the most

eligible place for him, where, if set at large, he would soon shift for himself. Of course his usual food would require to be found on the spot.

Dr J. A. Smith said, with regard to Mr M'Kenzie's statement that he could discover no air-holes in the lodges of the beaver, and wondered how they managed to do without air; it was probable the air got access through the comparatively looser structure of the top of the lodge, which Mr M'Kenzie states is always moist or wet even in the coldest weather, while the sides are frozen outwardly.

2. *On an apparently New Form of Holothuria.* By JOHN ANDERSON, M.D.

In the autumn of 1859 I dredged from five fathoms water in Bressay Sound, Shetland, the *Holothuria* which forms the subject of this memoir. The dorsal region of the body, when the creature is contracted, is a deep purplish brown tint, but the central surface is of a paler hue. When contracted, it is little more than a quarter of an inch in length, and about the fifth of an inch in breadth; but when distended and moving about, it becomes double this length, and its breadth also is slightly increased. The five double rows of sucking feet are unsymmetrical, the two dorsal rows being irregular in their distribution. The dorsal feet are less numerous than the ventral, which they greatly exceed in size, and from which they differ very much in their undilated tips, and by their being seated, in some instances, upon rounded eminences or tubercles. Though the two dorsal rows of feet differ very much from the ordinary arrangement of these organs in the *Holothuriadæ*, yet we can trace faint indications of the double character of the rows. The three double rows of ventral sucking-feet are fully developed; the feet are placed opposite to one another, and are dilated at their tips, but are only partially retractile. The animal walks upon three well developed rows, and if turned upon the aborted ones, it immediately recovers itself, and turns round to what appears to be its ventral surface. The tentacles are ten in number,—eight of them are long, pedunculated, and alternately branched, and the other two are short, and divided at their tips. They are all of a pale yellow colour, very pellucid, and are about a fifth of the length of the body when it is fully extended. The two short tentacles correspond to the two tuberculated rows of feet of the dorsal aspect. The body of the animal is covered with calcareous plates of an irregular form, and perforated by nearly circular holes. The plates found in the feet of the three central rows are spindle-shaped, but they change their form in the feet immediately surrounding the head, and become in appearance very similar to the plates found on the body-skin. The plates of the dorsal tubercles and feet resemble, in their irregularity, the plates of the body of the animal; and the same may be said of the plates found in the tentacles, in which they may be found extended to their ultimate divisions.

3. *Notes on the Ornithology of Caithness.* By R. I. SHEARER, Esq., Ulbster House, and H. OSBORNE, Esq., Wick. Communicated by the Secretary.

Wednesday, 26th February.—JOHN COLDSTREAM, M.D., President, in the chair.

The following communications were read:—

1. *Exhibition of Drawings, by Native Artists, of Animals collected in India, belonging to the different great divisions of the Animal Kingdom.* By WALTER ELLIOT of Wolfelee, Esq. Communicated by JOHN COLDSTREAM, M.D.

2. *Observations on British Zoophytes*.—1. *Atractylis arenosa*. 2. *Atractylis miniata* (new species). 3. *Laomedea* ———? (new species). By T. STRETHILL WRIGHT, M.D.

3. *On the Geological Age of the Pagan Monuments of the Outer Hebrides*. By Captain F. W. L. THOMAS, R.N.

(This paper appears in the present No. of the Journal.)

4. *Description of several Fishes from Old Calabar*. By JOHN CLELAND, M.D., Glasgow. Communicated by WILLIAM TURNER, M.B.

The specimens now exhibited were given me by our late lamented Treasurer, Mr Oliphant, and it was his desire that they should be shown to this Society. They come from Old Calabar. They are not in very good preservation, but are sufficiently so for the determination of their characters. Besides a small specimen of *Chromis niloticus* (Cuv.), there is an *Eleotris* and four fishes of the family *Siluroidei*, none of which correspond with species described in the work of Cuvier and Valenciennes, or such other books as I have been able to consult. They may possibly be mentioned in recent monographs which I have not had an opportunity of seeing.

1. The *Eleotris* presents well the characters of that genus, the head being much depressed, the body slender, the eyes remote, the gape very large for the size of the body, and the lower jaw prolonged beyond the upper, so as to give the mouth an upward direction, which may probably be looked on as convenient to a fish inhabiting the muddy parts of the water, and preying upon animals swimming overhead. Also, it shows well the appendage behind the vent and the ununited ventral fins, which distinguish this genus from *Gobius*. It has no vomerine teeth; its scales are small; its total length to the tip of the caudal fin is five inches. The caudal fin is one inch long and rounded.

The number of the fin rays is as follows:—first dorsal eight, second dorsal ten, caudal thirty-two, anal nine, pectoral sixteen, ventral six.

2. Of the *Siluroid* specimens one is a *Synodontis*, and corresponds exactly with a specimen in the British Museum. I believe that it is the *Synodontis serratus*, although the number of its fin rays agrees rather with that attributed to *S. arabi* in the work of Cuvier and Valenciennes.

The anterior dorsal fin has eight rays, the first of which is, as in all the members of the genus, a long and strong slightly curved spine fixed at right angles to the body. This spine is toothed on its posterior edge, and towards the point anteriorly.

The posterior or fatty dorsal fin, half an inch high and two inches long, is continued further back than the posterior margin of the anal fin. The caudal fin is bifurcated, the superior half longer than the inferior. From the longest ray above to the longest below, inclusive, there are seventeen rays; and outside these there are eleven shorter rays in each half. There are thirteen rays in the anal, nine in the pectoral, and seven in the ventral fin. The first pectoral fin ray in *Synodontis* is a large spine toothed before and behind, the posterior teeth being longest, about equal in length to the dorsal spine. There is no locking arrangement in its joint, and therefore it can only be kept in the extended position by muscular effort. On the other hand we find the lock joint of the pectoral spine in genera in which the dorsal spine is not fixed, as in this genus.

The superior scute of the head passes back nearly as far as the third dorsal fin ray. The coracoid scute is triangular, and passes back as far as the superior scute.

The long curved teeth which hang loosely in the lower lip, and which



give character to the genus, are twenty-four in number. Behind them are fine velvety teeth, the patches of opposite sides distinct. In the upper jaw there is a double row of conical teeth, about eighteen on each side, and behind them (on each side) a patch of setose teeth of very irregular size.

There is one superior pair of barbules very long and simple, and two inferior pairs, both of them branched, the outer pair half the length of the superior pair, and the inner pair half the length of the outer.

The specimen is twelve inches long from mouth to tip of tail, and three inches from mouth to the first dorsal spine.

A view of the swimming-bladder of *Synodontis* is given by Müller in his work on Myxinoid fishes.

3. Two of the specimens exhibited belong to the genus *Clarias*, which is characterised by the presence of arborescent branchial appendages attached to the second and fourth branchial arches, and by having only one dorsal fin.

The first of them corresponds exactly to one which I have had the opportunity of examining in the British Museum, and which, therefore, we may expect to have properly described by Dr Gunther in his elaborate work, of which part is already published. The specimen is a foot long. The head is depressed and shielded, oblong in form, the eyes small and lateral; the body is oblong, compressed. The dorsal fin extends from within an inch behind the head back to the tail, but is not continuous with the caudal fin; it contains seventy-six rays, the first of which is not spinous.

The caudal fin contains twenty-four rays, the anal sixty-three, the pectoral twelve, the ventral six. The first ray of the pectoral fin is a spine toothed before and behind, and having a lock-joint, that is to say, its joint is so constructed that when the spine is fully extended it cannot be pushed back towards the body by any direct pressure, but must first be rotated to a certain extent, and then it folds back easily. The anal fin is continued, like the dorsal, back to the caudal, without being continuous with the latter. There is a papilla behind the anus.

The teeth are velvety, in very broad patches. The teeth in the upper jaw are larger than those in the lower; the patch in the lower jaw is broader than that in the upper, and indented at the outer side. On the vomer there is also a broad patch of very minute teeth.

The barbules are eight in number. The anterior superior pair are longest, the external inferior pair slightly longer than the posterior superior pair, while the internal inferior pair are thick, short, and truncated, a character peculiar to this species.

4. The other *Clarias* which I exhibit, resembles two of the Indian species, viz., *Clarias Nieuhoffi* and *Clarias jagur*, in the dorsal and anal fins being continuous with the caudal. It has only one arborescent branchial appendage on each side, which is attached to the fourth branchial arch, and is very small. The specimen is eight inches long to the tip of the caudal fin, the latter being three-fourths of an inch long. The head is depressed, not shielded, three-fourths of an inch long, the body compressed. The barbules are eight, the branchiostegal rays nine. The anterior superior barbules are broadly membranous at the base.

The teeth are velvety, the patch on the lower jaw is much larger than that on the upper, and there is a patch on the vomer.

The dorsal fin begins an inch behind the head; it has no spinous first ray. The rays in it and the anal fin are very numerous. The pectoral fins are small, and have six rays, the anterior ray being a short spine, less than half the length of the succeeding rays, and not lock-jointed. The ventral fins are small and contain three rays.

5. The remaining specimen is a species of *Heterobranchus*. *Heterobranchus* is a genus allied to *Clarias*, having the same sort of arborescent branchial appendages, but having two dorsal fins, the posterior of which is fatty.

The specimen is five and a half inches long, three-fourths of an inch of this length belonging to the caudal fin. The appendages will be seen on the second and fourth branchial arches.

The head is very much depressed, broad, shielded, the eyes lateral, the barbules eight.

The branchiostegal rays are eight. The first dorsal fin has thirty-five rays, the first one not spinous, it ends behind the middle of the body. The fatty dorsal fin extends from the true dorsal to the tail, and contains traces of eighteen very fine rays. The caudal fin has twenty-two rays, it is rounded, and is tipped with black, as are also to a less extent the other fins, and the dorsal aspect of the head is also black. The anal fin has forty-seven rays, and extends from anus to tail. The pectoral fin has ten rays, the anterior ray toothed and lock-jointed, shorter than the succeeding rays. The ventral fin has six rays.

The teeth are velvety, in elongated narrow patches, one of which is on the vomer.

5. *Note on the Omnivorous Character of the Food of the Common Squirrel* (*Sciurus vulgaris*). By THOMAS DURHAM WEIR of Boghead, Esq. Communicated by Dr J. A. SMITH.

6. *Ornithological Notes*. By JOHN ALEXANDER SMITH, M.D.

The following specimens were exhibited:—

(1.) A pied variety of the blackbird, the head and upper parts of body being variegated with numerous pure white feathers: it was shot near Dundas Castle on the 3d of February.

(2.) A male and female *crossbill*, in fine plumage, killed near Aberdeen on the 13th January.

(3.) *Picus major*, the pied or great spotted woodpecker, an adult male specimen. It was found dead in the shrubbery of T. Durham Weir of Boghead, Esq., Bathgate. It seems not to have been before observed in this county, as it is not included in the list of the birds of Linlithgowshire, by the Rev. John Duns, recently published in the Proceedings of the Royal Society. Mr Small, bird-stuffer, George Street, sent a specimen of a young male, which was shot at Kirkwall, in Orkney, on the 4th of December last; and Mr J. Carfrae, Princes Street, informed Dr Smith that another was killed in Orkney in August last.

(4.) *Hybrid Grouse*. Two male Hybrids, between blackcock and red grouse. They agreed closely with the description given by M'Gillivray in his *British Birds*. They were procured from the Pentland Hills, about twelve miles west of Edinburgh, in the beginning of December last, by Mr Aitken, farmer, Listonshiels.

(5.) A fine specimen of the *Bittern*, which was shot near Balerno on the 24th January. The bird was a male, and its stomach contained a couple of frogs. Another specimen (a female) was shot in Berwickshire between Ayton and Coldingham, in October last.

(6.) A specimen of the *Great-crested Grebe*, shot at Queensferry on the 27th January. Its stomach contained the ball of feathers which is so often found in the grebes. Dr Smith considered it to be simply a 'pellet,' which the bird casts up, as in the hawk, &c.; the feathers assisting to brush out from the stomach the spiny remains of shrimps, &c., which were combined with the mass. A pair of *Sclavonian Grebes*, in their summer plumage, shot by Mr F. Campbell, on the 20th of June 1860,

on a loch in his property of Ormsary, Argyle. These birds are not known to breed in Scotland. In this instance they were manifestly rearing a brood of young. *Podiceps auritus*,—the eared grebe,—found by Mr John Blackwood, George Street, in the early part of January, on the sea-beach in the grounds of Lord Rosebery, near Queensferry. It is rarely seen, and is easily known by the peculiarly recurved or bent-up bill, and its small size.

7. A large specimen of the wild cat (*Felis catus ferus*), shot on the property of the Earl of Seaforth, in Inverness-shire, was exhibited by Edward Hargitt, Esq.

8. A fine specimen of *Astrophyton scutatum* * (Linck), (*Asterias caput medusæ*, Lin., Mull., &c. ; *Asterias arborescens*, Pennant), was exhibited by Robert Brown, Esq. It was obtained during an Arctic voyage, undertaken during the year 1861 (Feb. 27 to Oct. 26), in order to study the Natural History of the seas of Spitzbergen and Davis' Straits.

The specimen was taken clinging to a whale-line from 150 to 200 fathoms, muddy bottom, about a mile off Cape Kater, on the west coast of Davis' Strait. He found nothing in its stomach, except a few Diatomaceæ, and a specimen of *Cedochilus arcticus* (Baird, in Appendix to Sutherland's Voyage, vol. ii.), the presence of which might be only accidental. It was loaded with ova of a deep-red colour.

Its occurrence is interesting, as a confirmation of the imperfect record of its being found in Waigat or Disco Fjord on the east coast of Davis' Strait, in the last century, by the celebrated and accurate Otho Fabricius. In his *Fauna Groenlandica*, p. 372 (Hafniæ et Lipsiæ, 1780) he says,—“*Asterias caput medusæ. Hanc in museo plurimum reverendi Dn. Egede de colonia Jacobshavn (ni fallor) missam vidi: unde concludo, in sinu Disco dari: non autem vivam ipse offendi.*”

In 1671, Martin, the surgeon of a Hamburg whaler, appears to have met with it in his “Voyage to Spitzbergen.” Though Captain Phipps (Lord Mulgrave), in his Catalogue of the Animals of the same sea, does not record it. (“Voyage to the North Pole,” *apud* Scoresby, “Arctic Regions.”)

Sir John Ross, in his Arctic voyage in 1819, obtained a specimen two feet in diameter, which was described by Dr Leach under the synonym of “*Gorgonocephalus arcticus*.” It is now in the British Museum.

Bishop Eric Pontoppidan in his “Natural History of Norway,” (Part ii. pp. 179, 180. Lond. 1755), gives a very recognisable figure and description of it, as indeed most of the older authors do. That of Professor E. Forbes, among its modern historians, is the only good portrait of it, but from the want of colouring, full justice is not done to the varied beauties of the star-fish.

The coloured figure in Griffith's Cuvier is a mere picture.

Mr Brown gave additional details of its natural history and synonymy.

Owing to the late severe winter of 1860–61, and the ensuing calm summer blocking up the shore with great masses of land ice, he was unable to get into water shallow enough for dredging; and other circumstances prevented his voyage being successful, in a scientific point of view. He had, however, to thank his friend, Captain George Deuchars of the “Narwhal,” for his kind assistance whenever it lay in his power.

* The specimen has been deposited in the Natural History Museum, University, Edinburgh.

Botanical Society of Edinburgh.

Thursday, 9th January 1862.—Professor BALFOUR, V.P.,
in the Chair.

An address of condolence to the Queen, on account of the death of His Royal Highness the Prince Consort, was adopted, and ordered to be transmitted to Sir George Grey.

The following Communications were read :—

1. *Description of a New Species of Clerodendron, from Old Calabar, Africa.* By Professor BALFOUR.

(This paper appears in the present number of this Journal.)

2. *Notice of a Diseased Condition of Beeches at Tynninghame, the seat of the Earl of Haddington.* By Professor BALFOUR.

Professor Balfour stated that he had received a letter from Dr Protheroe Smith, enclosing one from the Earl of Haddington, relative to a peculiar diseased condition of beeches at Tynninghame and Mellerstain. The letters were accompanied by specimens of a cottony matter which had appeared in large quantity on the beech stems. Dr Balfour had written to the Earl of Haddington on the subject, and had received the following reply:—"In regard to the specimens of the 'peculiar substance' which your letter relates to, I certainly am very desirous to know about it. I wish much to know whether it only appears upon trees already in a dying or failing state, or whether it destroys the tree upon which it appears. There can be no doubt that in every case where seen the tree dies. It is much more prevalent at Mellerstain than it is here, and very many of the beeches there are condemned. In some cases the whole of the tree is completely covered with the substance, looking at a distance as if it were painted white. In some cases, only one side of the tree is diseased. I have been told that when it once appears in a wood it spreads rapidly; and from what I have seen at Mellerstain, I have too good reason to believe that such is the case." He had submitted the matter for examination to Mr W. R. M'Nab, and to Mr James Hardy, Penmanshiel. Mr Hardy says—"The cottony substance sent is produced by *Coccus fagi*, Walker, List of Homopterous Insects in the British Museum, p. 1086, No. 32, with the specific character, 'yellow, elliptical, covered with white powder; length of the body two lines.' This is the second time it has come under my notice. At first I had it from Mr C. M'Intosh, then of Dalkeith, and gave an account of it in the second volume of the "North British Agriculturist." It occurs near London. Can it have been introduced from abroad with foreign beech plants? I find the cast wrapper of a caterpillar among the cotton of the *Coccus*, and formerly there was one alive concealed by it; but whether it feeds on it, I cannot say, but it is not unlikely. The *Coccus* will be difficult to extirpate, for it is not easy to scrape the bark and apply hot water to a beech.

Mr W. R. M'Nab remarked that Mr M'Intosh had noticed a similar diseased condition of the beech-trees in Dalkeith Park, and had recorded the facts in the first volume of the "North British Agriculturist." He seems to have considered it a fungus. The cottony matter was at that time sent to Mr Hardy, who ascertained that it was owing to an insect, and gave a description of it in the second volume of the same journal.

Mr M'Nab thinks the *Coccus fagi* appears only on trees in an unhealthy condition, or at least in situations where they are confined in their growth by close planting. Dr Balfour stated that the same species of *Coccus* had destroyed some beech-trees in the Botanic Garden, which had been planted very closely, and were hemmed in by shrubs and trees. It seems to attack healthy trees. The only remedy suggested was the application of spirit of tar or tobacco-juice. Dr Balfour remarked that the species of *Coccus* were often very destructive. One of them in 1842 destroyed the whole orange-trees in the island of Fayal, one of the Azores. The usual exportation of fruit from Fayal was 12,000 chests, but in 1842 there was not one. The insect extended its devastations to St Michaels. It was *Coccus hesperidum*. Specimens of the beech-insect and of the cottony matter were shown.

3. *Notes in Reference to the Bursting of the Spathe of Seaforthia elegans.*
By Mr JOHN SADLER and Mr WILLIAM BELL.

In this communication the authors first referred to an article which had lately appeared in the "Gardener's Chronicle" from the pen of Dr Seemann, describing the bursting of a spathe of *Seaforthia elegans*, with an audible report, "almost loud enough to have proceeded from a pistol," in the Palm-House at Kew—the explosion being attributed to "a great accumulation of heat, developed by the anthers whilst inside the spathe." The authors then stated that they had had ample opportunities for observing the flowers of the *Seaforthia* in all their different stages of development in the Palm-House at the Edinburgh Botanic Garden, and as yet had never seen anything which gave the least indication of a sudden rupturing of the spathe. In some cases they had seen the old foot-stalk of the leaf which covered the spathe fall off two or three days before the spathe showed any signs of bursting; and when it did burst, it opened gradually from the base to the apex, generally on the dorsal aspect; indeed, they had only observed a single instance where the rupture occurred on the ventral side. Again, they had seen the spathe burst two or three days before the old foot-stalk fell off, and when it fell upon the floor it generally gave a pretty sharp crack, which they thought had been probably regarded as proceeding from the bursting of the spathe, as Dr Seemann states that the spathe in bursting "forced off the remnant of the old leaf-stalk." When the spathe bursts previous to the fall of the foot-stalk that covers it, as soon as it is removed the branches of the spadix immediately expand, and, to all appearance, it looks exactly as if the spathe, in the act of bursting, had knocked off the foot-stalk. Dr Seemann supposes that the report was due to an accumulation of heat, produced by the anthers. This, however, the authors thought could not be the case, as a considerable time elapses between the bursting of the spathe and the opening of the flowers; this they had never observed to be less than three weeks, and generally more than a month. A tree in the Palm-House at the Botanic Garden burst its spathe five weeks ago, and had not yet a single flower expanded. After the bursting of the spathe the branches of the spadix continue to increase both in length and thickness; and until they have reached their maximum development, they had never seen a single flower expand. Dr Lindley, in his "Introduction to Botany," and Dr Balfour, in his "Class-Book," both state that the greatest amount of heat during the period of flowering is when the anthers are ready to discharge their pollen, after which it gradually declines. At the time the spathe bursts the flowers are in a very imperfect state, the stamens being very immature, with no traces of pollen. The observations of the authors went to show that there was rather less heat inside the spathe before it bursts than there was in the surrounding

atmosphere. They had inserted a thermometer by a narrow slit into an unburst spathe, where they allowed it to remain upwards of twenty minutes, and when taken out it stood at $57\frac{1}{2}^{\circ}$, while the surrounding atmosphere was 58° . Taking into consideration the structure of the spathe, the authors showed that it was incapable of sustaining any great amount of pressure, as it was found, when in a fresh state, to tear lengthways with as little resistance and with as little noise as a piece of soft paper.

4. Notes regarding some New and Rare British Mosses.

By Mr JOHN SADLER.

Mr Sadler stated that, as he had received several letters from correspondents during the last few months, containing valuable information respecting some interesting British mosses, he thought it well to bring before the Society a few extracts from these communications, in order that they might be recorded in their Proceedings.

(1.) From Mr WILLIAM WILSON, Paddington, near Warrington.

"We have near Warrington an excavation at the side of the railway whence the embankment of the railway is supplied. In the marsh thus formed has appeared, along with *Bartramia fontana*, a new and allied species *B. (Philonotis) cæspitosa*, which Schimper has found in Sweden; but it seems otherwise a stranger. There are also many good mosses in this swamp not known to grow very near to it elsewhere. On the other hand, several mosses, which do grow not far off in similar situations, do not grow there; but *Bryum bimum* and *B. pallens* are there in great plenty, and in very fine state. *B. annotinum* is there also, and bears fruit.

If *Philonotis cæspitosa* does not bear fruit this spring I shall send you living plants (male and female) to be nursed up to perfection in your stoves. I think that *Hypnum elegans* may also require some such treatment. It is plentiful enough in Britain; but the fruit is very rare. The plant resembles *H. cordifolium*, and has been overlooked as a variety; but it is a dioecious moss. The bog at Wybunbury, in which it occurs sparingly in fruit, has been recently drained, and will soon be destroyed as a station for mosses."

(2.) From Dr J. B. Wood, Manchester.

"*Tortula Mulleri* has been gathered for several years near Blair Athole, by Miss M'Inroy of Lude. *Bryum Duvalii* was gathered about two years ago by Mr Nowell on Helvellyn. I enclose you specimens of, 1. *Hypnum Eugyrium*, of Schimper's "Synopsis," 1860, from near the Rumbling Bridge, Fifeshire, collected June 1861. This is the first time that this moss has been detected in Scotland.* 2. *Orthotrichum anomalum* of Hedwig's "Bry. Europ.," not of Hooker and Taylor, nor of "Bry. Brit.," which is *O. saxatile*, Bridel. vide Phytol. On detached rocks near Aberdour, June 1861. 3. *Orthotrichum Sturmi*, Ombeg Dalvarlia, Zettersteat legit, Schimper misit! Fruit not good, and scarce. I will

* In this, however, Dr Wood is mistaken, as I find that the plant was collected in April 1858 by the late Dr William Nichol, at the Grey Mare's Tail, in Moffatdale, and recorded by him in the Society's "Transactions," vol. vi. p. 140, where he says, "*Limnobium (Hypnum) Eugyrium*, Sch., Grey Mare's Tail, in fruit. This plant is not recorded in Wilson's "Bryologia Britannica," having at that time been confounded with *Limnobium palustre*, Sch. It may, however, be easily distinguished by its yellowish aspect and the much enlarged alar cells of the leaf. The only other British stations are Turk Cascade, Killarney, and Aber Waterfall, North Wales."

send you a British example when I have time. You may value these as coming from such a source."

(3.) From Mr JAMES HORSEFIELD, Whitefield, near Manchester.

"I take the liberty of sending you specimens of *Tortula marginata*, *Entosthodon Templetonii*, and *Dicranum crispum*, all of which I have gathered in this locality."

(4.) From Mr JAMES COOK, Manchester.

"Enclosed are specimens of *Orthodontium gracile* from Mr Wilson's station, Alderley Edge, Cheshire, and *Atrichum laxifolium* from Staley Brushes, Ashton-under-Lyne. The latter moss is not named in Wilson's "Bryology;" but specimens from the same station were sent to Dr Schimper, who named it as above. It has not yet been found in fruit in Britain."

(5.) From Mr JOHN NOWELL, Todmorden.

"I met with *Bryum Duvalii* on Helvellyn in July 1859; but not knowing anything of that plant then, I thought it might be a form of some other *Bryum*, and unfortunately did not procure much of it. Very soon afterwards a friend of mine sent me a small scrap of the moss gathered by Dr Nichol, and it turned out to be identical with the one I had picked on Helvellyn. I enclose a few specimens of mosses, and hope they will prove acceptable. One of them is the *Atrichum laxifolium* of Wils. MSS. of James's Plants of New Jersey. I have known this moss for a good number of years, and have shown it to several botanists, who have come to the conclusion that it might be a form of *A. undulatum*, or perhaps turn out to be *A. tenellum*. Last year specimens of it were sent to Dr Schimper, who pronounced it the true *A. laxifolium*, and new to the Flora of Europe. It is not unfrequent by the sides of streams on the hills in this district; and it has lately been found in one or two other places in Lancashire. Mr Wilson has also found it on the edge of Oak Mere, in Cheshire. Only the male plant has been detected in this country. *Bryum stellare*, on moist shady rocks, Shedden Clough, near Barnsley, Yorkshire. *Mnium subglobosum*, boggy moors, near Todmorden."

(6.) From Mr GEORGE BREARLY, Milnrow, Rockdale.

"I have sent you *Dicranum Dillenii*, from near Garstang, *Hypnum riparium*, from near Milnrow: *H. polygamum*, *Bryum calophyllum*, *B. Warneum*, &c., from near Southport, collected November 1859."

(7.) From Mr ALEXANDER M'KINLAY, Glasgow.

"I enclose *Orthotrichum orneum*, of Dr Schimper's MSS. (*O. Daliense*, Wils. MSS.) gathered on ash trees near Dailly, Ayrshire; discovered by Mr John Shaw, June 1860. *Zygodon conoides*, old trees, Dailly, May 1860: *Hypnum hamulosum*, *H. umbratum*, and *H. crista-castrensis* in fruit, Trossachs, 1860. *Tortula rigida*, on clay, by the Paisley Canal, near Glasgow, September 1860."

In a letter which I received from Mr Wilson, and published in the Society's Transactions, vol. vii., p. 107, he says:—"The late Dr Nichol sent me some years ago a small specimen of a moss which he considered to be *Atrichum tenellum*, gathered near Lochgoilhead in 1856. This I cannot find in my herbarium, after repeated search, nor elsewhere among my papers, and I have no memorandum of having examined it. I am particularly desirous to receive from you a duplicate of this moss, that I may ascertain what it really is. I hope it is *Atrichum tenellum*, but have much doubt on the subject. It may prove to be the same as a new

British species allied to *A. tenellum*, and which I believe we must now call *A. crispum*."

Mr Wilson now writes, December 27th, 1861 :—

(8.) "Since I wrote to you I have been fortunate enough to find the lost specimens of *Atrichum tenellum*, sent to me by Dr Wm. Nichol, in August 1858. It quite agrees with authentic specimens from Dr Schimper—I am sorry I cannot spare any of the Scottish ones; for I have only two stems with fruit (unripe). These agree in size and character with what I send enclosed. The habitat given is "near Loch Goll Head, on a sandy bank by the side of road thence to St Catherine's, Loch Fyne Side, not far from the head of Hell's Glen, 1856." I am very glad to have established the claim of Dr Nichol to be remembered as the discoverer (in Britain, &c.), of the true *A. tenellum*. Is there any prospect of getting a supply of the moss (now in season)? The habitat seems to have been very exactly noted, and I should have no fear of finding it. The short capsule distinguishes the moss at once from *A. undulatum*; but it is also distinct in inflorescence, being dioecious. I wish I could see the fertile specimen of *Hypnum sarmentosum*, gathered on Ben Beck, July 1845, by Wm. Gardner. The loan of it would oblige, and I would carefully examine and return it. The only satisfactory way in such cases, is to disentangle, and completely separate the specimen from all its accompaniments. Has this been done? The mere presence of a capsule in a tuft of the moss is not at all conclusive evidence. I am rather dubious about *Orthotrichum speciosum*, from Penton Linns, 1858, Dr Nichol. The specimen is much overripe and meagre. Most of the specimens sent by Dr Nichol as *O. pulchellum*, trees, Annan water, near Moffat, April 1858, seem to belong to another species, and should be well compared with *O. patens*, a species I do not yet properly understand. It appears that *Dicranodontium longirostre* does really grow on Ben Lawers as well as on Ben Ledi, as I have a specimen gathered this year from Mr M'Kinlay. Enclosed are specimens of *Hypnum speciosum*, collected near Penzance, December 1861."

(9.) *Dicranodontium longirostre* was first detected by Mr Wm. Bell on Ben Ledi in July 1860; and Mr Wilson, in a note to him, says:—"You have gathered another interesting moss on Ben Ledi, about whose exact locality I should be glad to have information. It is *Dicranodontium longirostre*. I have never spent much time on that part of Ben Lawers where you found *Bryum Duvalii*. Indeed, I have only twice passed over that ground, and then in haste. I may mention that when Dr Schimper was over here, he called many specimens which I showed him, '*Bryum turbinatum*,' which I knew to be a variety of *B. pallens* only. This shows how easily they may be mistaken for each other in a dry state. *Bryum turbinatum* is a very rare moss in Britain. Hitherto only three stations have been found, and two of these are already destroyed. I have never gathered it myself with fruit, and very few such have been gathered at all."

(10.) From Mr WILLIAM BELL, Edinburgh Botanic Garden.

"In the month of April last I spent two days in the neighbourhood of Moffat. Amongst other places of interest to the muscologist I visited Dob's Linn, where I met with *Zygodon Mougeotii* in fruit, a thing apparently of rare occurrence, the only other British specimen in fruit being gathered by Professor Walker-Arnett somewhere on the Clova Mountains. In the woods of Dumcrief I gathered *Orthotrichum phyllanthum* and *O. stramineum*. I found *Mnium stellare* and *Bryum Duvalii* abundant in Dr Nichol's stations—the former by the roadside between Moffat and the Grey Mare's Tail, and the latter at the source of the Mineral Well Burn. During last summer I collected *Fissidens serrulatus*, on Arthur's

Seat: *Fissidens viridulus*, in Greyfriar's Churchyard: and *Pottia Wilsoni* on the top of an old wall near Haymarket Station. These three species, I believe, have not been hitherto observed in the neighbourhood of Edinburgh. I have found *Tortula papillosa* on an ash tree in the Botanic Garden; on the trunk of a large willow lying in a woodyard between Broughton Place and Leith Walk; and also on ash trees a little to the east of Gilmerton. Dr Nichol mentions having found it 'on a rock on Arthur's Seat; a very anomalous situation.'"^{*}

Specimens of the various species of mosses referred to were exhibited.

5. *Remarks on the Specimens of Araucaria imbricata in the Botanic Garden.* By Mr M'NAB.

The ever-memorable 24th December 1860, when the thermometer in the Botanic Garden stood at -6° , injured to a fearful extent many trees and shrubs, which had stood during the last half century unprotected and uninjured. Foremost amongst the victims was the *Araucaria imbricata*, first introduced into Britain in the year 1796 from Chili, where it is found growing with stems 150 feet in height. The first symptom of injury observable on the two largest plants in the garden was the peculiar drooping of all the points, both primary and secondary, of every branch. As the spring advanced, the drooping points became brown, and were ultimately blown off. During summer all the lower branches and the points of the upper ones also became brown and dry, so much so that their removal was absolutely necessary. As the season advanced, not a green portion was to be seen. After the top shoots became brown, the stems began gradually to die downwards. The finest plant was cut down exactly one year after being injured, when two or three inches only of the stem, close to the surface of the ground, were found to be healthy, and from which it is expected buds will push during the coming spring. The smaller-sized specimens cut down last year commenced to give out buds immediately. The lower they are cut the fewer and stronger will be the shoots produced. These must be finally thinned out to single stems. It is curious to observe four plants in the garden having their top-whorls perfectly fresh but denuded of all the lower branches, probably arising from the depth of snow which rested on the upper whorl; while those having a terminal shoot above the upper whorl all died. The few plants saved appeared more delicate than the two noble plants which stood at each end of the long terrace lawn, and where the subsoil is deep dry sand, but both are now dead. During the last fifteen years, the two large plants were regularly supplied every May each with thirty barrels of water, besides a triennial renewal of the soil round the extremities of the roots, composed of very old rotted manure and loam. This may account for the very large size of the annual layers produced during the last fifteen years, compared with those sections where no extra water was given. For many years past a good deal of speculation has been going on with reference to the tiers of branches, as compared with the probable age of the trees. The cutting down of different sized trees in the Garden has given us an opportunity of setting this matter, so far, at rest. The largest plant cut down was 24 feet 6 inches high, and 4 feet in circumference at the base. This plant has 30 perfect annual rings, and 20 perfect whorls of branches, proving that eighteen months are necessary to complete one internode and whorl. Two others cut down, both about 16 feet in height and 15 perfect tiers of branches, besides an unbranched terminal shoot, and 23 annual rings. Many others averaging 8 feet in height have 8 perfect whorls, with unbranched terminal shoots, and about

* Bot. Soc. Trans. vol. vi. p. 110.

13 annual rings. To tell the age of a growing plant of *Araucaria*, count the tiers of branches, and add one-half the number, making allowance for the unbranched terminal shoot, if any; this will give nearly the age of each tree. Some of the older plants, particularly those which had been confined in pots during their early growth, show a slight discrepancy in the lower whorls; in general the above test will be found very near the truth. It is not to be expected that plants ill-treated, or growing in very exposed situations, or bad undrained soil, will at all answer the above test. *Araucaria* and *Altingia* are perhaps the only plants whose external appearances indicate their exact age. Mr M'Nab exhibited a section of the stem of the largest *Araucaria*.

6. *Notice of a Plant called by Travellers in Canada the Polar Plant.*
By WILLIAM GORRIE, Esq.

Mr Gorrie called attention to the various notices of this plant in different works, and stated that he was unable to determine the correctness of the observations, or to ascertain the botanical name of the plant to which allusion was made. The following are some of the references to this plant:—1. "The Scalp-hunters," by Captain Mayne Reid, 1852, p. 206—"But we had a guide to our direction unerring as the magnetic needle. We were traversing the region of the 'Polar plant,' the planes of whose leaves at almost every step pointed out our meridian. It grew upon our track, and was crushed under the hoofs of our horses as we rode onwards." 2. "The City of the Saints," by R. F. Burton, 1861, p. 60—"Whilst in the damper ground appeared the Polar plant—that prairie compass, the plane of whose leaf ever turns towards the magnetic meridian." 3. "The Prince of Wales in Canada and the United States," by the *Times*' Special Correspondent, 1861, p. 300—"Fortunately none go to the prairie for the first time without being shown, in case of such mishaps, the groups of compass weed which abound all over the plains, and the broad flat leaves of which point due north and south with an accuracy as unvarying as that of the magnetic needle itself." 4. "Notes by Lieutenant-Colonel W. H. Emory, made in 1846-47, with the advance guard of the 'Army of the West,'" 1848, p. 11—"On the uplands the grass is luxuriant, and occasionally is found the wild tea (*Amorpha canescens*) and *Pilot weed* (*Silphium laciniatum*). The low grounds abound in prickly rush, narrow-leaved asclepias, while flowering indigo, flowering rush, spotted tulip, bed straw, wild bergamot, spiderwort, pink spiderwort, pomme blande (*Psoralea esculenta*), scarlet malva, *pilot weed*, hazels," &c. Again, at p. 143 of same work, "*Silphium laciniatum* (*pilot weed*) was found on the Arkansas and its tributaries. Another *Silphium*, with large ovate undivided leaves, was found in Cario Creek, in lat. 32°, long. 116°, Old California." In same work, Appendix, No. 6, Lieutenant J. W. Albert's Notes, p. 388—"The prairie was yet what is called rolling; the flat bottoms were covered with the rosin weed or *Polar plant* (*Silphium laciniatum*), whose pinnate parted leaves have their lobes extending like fingers on each side of the midrib. It is said that the planes of the leaves of this plant are coincident with the plane of the meridian; but those I have noticed must have been influenced by some local attraction that deranged their polarity." Mr Gorrie stated that there was no notice taken of the "Polar plant" either in Strausburg's "Expedition to the Great Salt Lake," 1852, or in Fremont's 1st and 2d editions.

Professor Balfour exhibited a photograph of a cedar of Lebanon (*Cedrus Libani*), which had been presented to the Museum at the Botanic Garden by the Right Hon. R. C. Nisbet Hamilton. The photograph was executed by Mr D. Campbell of Ayr. The following are the particulars

relative to the tree :—It grew at Beil, where it was planted in 1707. It was measured on December 23, 1861—

Height,	.	.	59 feet 3 inches.
Girth at the root,	.	.	16 " 1 "
Do. at 4½ feet,	.	.	18 " 6 "
Spread of branches,	.	.	77 " 3 "

Mr W. R. McNab exhibited specimens of the pine-destroying beetle (*Hylurgus piniperda*), which had been sent from Churchill, Verner's Bridge, Mayo, Ireland, by Mr J. B. Webster, wood forester to Sir William Verner, Bart., M.P. Shoots of the pines destroyed by the beetle were also shown.

Professor Balfour stated that he had received a letter from Dr Cleghorn, dated Cawnpore, 2d December 1861, in which he states that he had been able to convey the *Cinchona* plants safely from Kew to Madras, and that he had despatched them to the Nilgiris to be planted. Dr Cleghorn was on his way to the Punjaub, to examine the forests there.

13th February 1861.—T. C. ARCHER, Esq., President, in the Chair.

The following Communications were read :—

1. *On the Farinaceous Grains, and the various kinds of Pulse used in Southern India.* By WALTER ELLIOT, Esq. of Wolfelee.

(This paper will appear in the next number of the Journal.)

On the Homologies of the Sporiferous Appendices of Anemia, &c.
By JOHN SCOTT, Royal Botanic Garden, Edinburgh.

The nature of the spores of ferns has long been, and still continues to be, an open question, in the history of their morphology, principally, perhaps, from the following peculiarities :—*First*, Their origin, as productions of a free cell-formation, like the pollen-grains of Phænogams, with which they have been considered as homologous, although subserving dissimilar functions. *Second*, The anomalous appearance of organs, supposed by many to exercise reproductive functions, upon a temporary structure, developed from the spore after its separation from the plant, which has given rise to the opinion of the spore being the homologue of the floral-bud in Phænogams. And again, *thirdly*, the fact that the spore, unlike the seeds of the higher plants, possesses an individuality which reproduces and establishes, with the utmost facility, any peculiarity that may appear on the pinna upon which it originates,—a property which in Phænogams is almost exclusively confined to the leaf-buds; hence the opinion that they are the homologues of the leaf-bud. These, then, are a few of the peculiarities of the fern-spore, which we fear will continue to tax the most ingenious of our vegetable morphologists for a satisfactory explanation of their homology.

The subject, however, which we have proposed for our examination at present has to do simply with the homologies of the parts bearing these organs, and is of a less complex nature than the one we have cursorily noticed. In the majority of ferns there is comparatively little difference between the sterile and fertile frond; in others, however, there is a very marked dissimilarity. For example, in certain genera of the tribe Schizæineæ, the morphological conformation of the spore-bearing parts is so peculiar—considering their relative position—that doubts are entertained as to their true nature, and we have at present two very different expla-

nations of their structure. The genera which have occasioned this difference of opinion are *Anemia* and *Anemidictyon*, and the first structural explanation of their fertile fronds, was, we suppose, proposed by Endlicher. He regards the fertile appendices in these genera as the lower pair of pinnae in a changed and modified state. The late Mr Gardner has, however, given a very different explanation: he regarded the fertile frond as compounded of three originally distinct fronds. The stipe parts being incorporated, separation taking place at the base of the rachis, where one assumes the appearance and habit of the normal barren frond; the other two, rising laterally from this, have the parenchyma almost entirely suppressed, forming two erect sporiferous appendices.

Among the arguments adduced by Gardner in support of this view, we may mention the following, which he considered as disproving the explanation given by Endlicher. The fertile fronds in the genus *Mohria* arise separately from the rhizoma, and do not differ in general appearance from the barren ones. In two ferns which Gardner discovered in Brazil, closely allied to *Anemia* and *Mohria*—to the latter, at least, in bearing distinct sterile and fertile fronds—abnormal specimens occur, in which the lower part of a frond alone is contracted and sporiferous, the upper a perfect fac-simile of the same portion of the barren frond. We may mention, e.g., that as he could not satisfactorily refer these ferns to any existing genus, he formed one for them—*Coptophyllum*. Smith, however, in his paper on the "Genera of Ferns," has referred them to the genus *Mohria*; and latterly, Moore, in his "Index Filicum," has placed them in *Anemia*. In these two abnormal specimens, then, we have the sporiferous parts in apparently the same conditions as occur in *Anemia*, so what explanation can be given of the diversity of appearance assumed by those parts in their respective genera, if we do not consider the fertile frond in *Anemia* as compounded of three? And again, he considered the idea of the mere transformation of the pinnae into the sporiferous parts disproved by the circumstance, that in *Anemia Mandioccana* the fertile spikes are opposite each other, while the pinnae alternate. We may here state that there can be little stress laid on the opposition of these parts, as it is not at all permanent. On looking over a series of specimens of *A. Mandioccana*, we observe that these parts are as often seen to alternate as assume an opposite position; and in *Anemia flexuosa* the fertile panicles are sometimes half an inch apart; at other times they are opposite; and so it is with many others belonging to the genus. It is evident, however, that the law regulating the fertile parts bears no relation to that observed in the arrangement of the pinnae, as there is always a regular alternation in the position of the latter, the distance between them decreasing from the base to the apex of the frond.

Having now stated the two opinions held regarding the structure of the sporiferous appendices of *Anemia*, we will attempt an explanation of the true nature of these parts, which we propose doing in the following manner—*First*, by examining the nature of the sporiferous parts in allied genera, in search of analogical elucidations; and, *secondly*, by laying before you a series of teratological illustrations from plants of *Anemia* and *Anemidictyon*. As the tribe Schizæineae is a very small one, we will give a cursory description of the sporiferous parts in each of the genera.

1. *Lygodium*, taking the *L. palmatum* as characteristic of the genus, which has a slender, wiry rachis rising from the rhizoma, bearing at intervals opposite pairs of dichotomous pinnae, reniform and palmate, the segments of the barren parts are fully half-an-inch broad. In some fronds we pass directly from these broadly palmate pinnae to the rachiform and sporiferous pinnae, which form a terminal panicle. At other times there is a more gradual transition from the sterile to the fertile parts,—e.g., in

a dichotomous pinnæ, one pinna alone is contracted and sporiferous, the other preserving the normal barren form, thus exhibiting a striking indefiniteness in the modifying cause. It is obvious, however, that the sporangia in this genus are borne in panicles formed by a transformation of the ultimate pinnæ.

2. In the genus *Schizæa* the fronds are simple, flabellate, or dichotomously multipartite, the fertile bearing on their apex a crest of linear sporiferous segments. This genus has been divided into three sections. In the first occurs the *Schizæa pusilla*, the fronds of which are simple and linear in the barren state; in the fertile, the apex is transformed into a reflexed crest of pinnate, linear segments, bearing the sporangia. In the second group occurs *S. dichotoma*, with fronds dichotomously multipartite; segments linear in the barren state; in the fertile the linear segments terminate in a pinnate sporiferous crest. Again, in the third section, we have *S. trilateralis*, the barren fronds of which are simple, linear, and triquetrous, the apex of these in the fertile state, as in the others, forming a crest of pinnate segments.

In this genus there is a striking departure from the normal structure of the frond—assuming the barren fronds as such—in the terminal crest of fertile segments, each of which is a miniature fac-simile of the sterile frond. Now, in some of these, e.g. *Schizæa bifida*, or in *S. pectinata*, there are from ten to twenty of these segments rising up in a more or less erect position from the reclinate continuation of the costa: so that if three fronds are required to form a fertile frond in *Anemia*, how many have we in that of *Schizæa*? There is, in fact, stronger presumptive evidence for the fertile fronds being compounded of a number, similar to the segments of the sporiferous crest in *Schizæa* than there is in *Anemia*, as in the latter genus we have in the pinnæ lateral appendages, which we might regard as the homologue of the sporiferous panicle; but in *Schizæa* we have no such appendages on the barren frond; consequently, admitting the fertile fronds of *Anemia* to be compounded of three from the tripartite condition of these fronds, we must, for consistency, give a similar explanation to the structure of *Schizæa*, and consider it as composed of a number similar to the sporiferous segments. But we fear that this view of the structure of the fertile frond of *Schizæa* would find few to support it; and, as we cannot apply the other view, from the absence of lateral appendages in the barren fronds, we must either consider the sporiferous crest as a special development—a superinduced structure—or, perhaps, with more propriety, regard it as a product of collateral chorization, for the barren frond has only an analogical affinity with the phyllodium. The structure of the fertile frond in *Schizæa*, when compared with the same in the other genera of the tribe, appears to be quite anomalous, consequently of no analogical value in illustrating the homology of the sporiferous parts in the other genera.

3. In *Mohria*, the sterile and fertile fronds rise independently from the rhizoma, the fertile being more or less contracted, at times forming a mere rachiform panicle, on which the sporangia are disposed. In *Mohria millefolium*, Smith, specimens sometimes occur in which the basal part of pinnæ alone are contracted and sporiferous,—a condition which Gardner thought confirmed his view of the structure of the fertile frond of *Anemia*. As in these abnormal fronds we have, according to Endlicher's view of the structure of *Anemia*, a conditional similarity between the two genera, and yet these abnormal forms of *Mohria* do not produce erect panicles similar to *Anemia*. Hence he seems to have concluded, as we stated before, that there must necessarily be a difference in the internal structure of the two genera to explain the difference in their morphological conformation. We may, however, remark that the basal sporiferous pinnæ of

Mohria do not stand in the same relative position to the others as the sporiferous panicles of *Anemia* do, so that there is, in fact, a difference in the external structure of the two which Gardner has entirely overlooked: the morphological influence it exercises we will fully elucidate in our observations on *Anemia*.

4. The genus *Trochopterus* is founded on a single species—*T. elegans*, discovered by Gardner in Brazil. The fronds are simple, subrotund, five-lobed, the two lower lobes contracted, laciniated, and bearing the sporangia. This curious little plant, whose fronds are rarely more than three-fourths of an inch long, and half an inch broad, differs from *Anemia*, according to Smith, only in habit,—the fronds being depressed, horizontal, closely imbricated, and developed in a regular spiral alternation, forming a flat circular patch an inch and a half in diameter. In this genus, then, as in the others which we have examined, *Schizaea* excepted, it is very obvious that the sporangia are borne on the more or less modified pinnæ of the individual fronds.

Next in succession, we reach the genera which have given rise to the difference of opinion—*Anemia* and *Anemidictyon*. In both the genera the fertile fronds are ternately branched; two of these branches are erect and sporiferous, the other spreading and sterile, similar to the barren frond characteristic of the species. We will now proceed to describe a series of abnormal forms, which we trust will illustrate most clearly the true nature of the sporiferous appendices in the true genera.

In our first illustration—*Anemidictyon Phyllitidis*—we have a barren frond, exhibiting a decided, though frustrated, tendency in the lower pair of pinnæ to form a normal sporiferous panicle. These pinnæ, instead of being entire and developed on the same plane with the others on the rachis, are pinnatisect, with lanceolate obtuse segments; they also assume the erect position, with their upper surfaces in opposition, like the normal sporiferous panicles. There is also observable a departure from the usual law followed in the rachidial disposition of the pinnæ by these abnormal forms. In a normal barren frond, the first and second pair of pinnæ are always farthest apart, a gradual decrease of the distance between them taking place from the base to the apex; whereas, in the specimen before us, the basal, pinnatisect pinnæ rise from the rachis scarcely half-an-inch below the second pair of pinnæ, while the distance between the second and third pair is nearly an inch and a quarter. In this case, then, we appear to have something analogous to the extra-axillary development of buds, an adhesion of the petiole with the rachis. Admitting the doctrine of secondary influences, we may assume *adhesion* in this instance, and accept it as a key for the explanation of the peculiar morphological conformation of the sporiferous panicles in *Anemia*. Our succeeding illustrations will, we trust, place on a more satisfactory basis the opinion we have here assumed, by showing that there is a certain apparent relation between the degree of modification of the pinnæ and the amount of their rachidial adhesion.

In our second specimen of *A. Phyllitidis*, the sporiferous panicles are both fully developed, the left side panicle being placed in juxtaposition with the barren pinnæ, as is usually the case; but on the right side the panicle is solitary, and a little below the first barren pinnæ on this side occur the pinnæ which normally ought to have been given off by the rachis, in proximity with the sporiferous panicle, as occurs on the left side. In this illustration, then, we have an example of the adhesion of two of the pinnæ with the rachis on the right side, both of which have undergone a complete transformation,—the first, or basal, being perfectly developed into a sporiferous panicle; the second assumes the form of a narrow linear rachis an inch and a half long, with eight or nine

sporiferous lobules forming a crest at its apex. The imperfect conformation of the secondary panicle may in all probability be attributed to the more rapid and powerful development of the primary or basal panicle. Now, as no doubt can be entertained that this secondary panicle, in ordinary circumstances, would have been developed as a normal barren pinna, we regard it as a most unequivocal demonstration of the opinion we assumed—viz., that the simple pinnæ of the frond, on adhering with the rachis, do partake of its nature, and assume its general morphological conformation.

In our third illustration—*Anemia collina*—there is a very slight adhesion of the lower pair of pinnæ with the rachis, and, consequently, they undergo a very trifling modification. They are about the same length as the ordinary barren pinnæ; but from the adhesion they have partaken of the rachidial habit, and rise up erectly, contracted, rachiform at the base, bearing small sporiferous segments, and terminating in a large obovate lobe. Again, in our fourth specimen—*Anemia collina*—we have a very clear demonstration of the dependence of the transformation on the degree of rachidial adhesion. In the specimen before us, the basal pinna on the left side has partially adhered with the rachis, and assumes the erect habit, the basal part pinnatisect, with a large terminal lobe; on the right side the lower pinna has had a greater adhesion with the rachis, rising from it a little below the secondary pinna, and here, though the development has been frustrated, the transformation is complete, as it has assumed quite a rachiform appearance, terminating in a small crest of sporiferous segments.

In the preceding parts of this paper, we referred to an argument Gardner drew from abnormal specimens, belonging to certain species of *Mohria*, which he thought supported his structural views of *Anemia*. These specimens—the structure of which we before noticed—he assumed to be in the same structural condition as the fertile fronds of *Anemia*, according to Endlicher's view; so, upon this purely negative evidence, he postulates that, as the conformation of the two are so very dissimilar, there must be a dissimilarity in their internal structure, hence the origination of his ingenious though unsubstantiated theory, that the fertile fronds of *Anemia* are compounded of three originally distinct fronds. The teratological specimens, however, that we have laid before you clearly demonstrate that there is a conditional dissimilarity in the external structure of *Anemia*, and the abnormal specimens in question, which must have escaped Gardner's observation, or no doubt the argument, which it nullifies, would not have been brought forward.

Before concluding our paper, we may cursorily notice a few objections to Gardner's theory, which occurred to us on first considering it, although from the want of the abnormal specimens we have placed before you, we were unable to give any satisfactory answer to his query, Why the pinnæ of *Anemia* assume such a peculiar conformation? First, then, in tracing the development of a fertile frond, we are at once induced to regard the fertile appendices as simply modifications of pinnæ, from the fact that they are primarily developed in the same order; whereas, had they been originally distinct fronds, the degree of "developmental energy" possessed by them would have been equal to the barren part, and thus demonstrated their nature by being developed in the same order. Again, on examining the veneration of the appendices, we find that it agrees perfectly with the other pinnæ; they simply fold over the first pair of pinnæ, as these do over the second, instead of being rolled up in a circinate manner, as the rachidial part invariably is.

The truth of the foregoing remarks, on determining the nature of the sporiferous appendices by their order of development, is practically eluci-

dated on tracing the development of specimens such as those we now lay before you, in which there has been a connection of stipes. In the first example—*Anemia collina*—the stipal parts have adhered for a short way, when a lateral separation takes place, and each part then assumes the appearance of a normal frond, having at its base the incipient fertile parts, which, from some unknown cause, have been arrested in their development. In a second example, we have, in a specimen of *Anemidictyon Phyllitidis*, a connation of three fronds, collateral separation taking place very near the base of the stipes. Two of the fronds are fully developed and fertile, the third was unfortunately broken; the pinnæ and fertile parts were, however, perfectly formed upon it. Now, in tracing the development of fronds such as these, we have no difficulty in discerning their compound nature at a stage prior to the development of the lateral appendages, which at once points to a structural dissimilarity; whereas, in a fertile frond of *Anemia*, the sporiferous appendices, as we stated before, follow the same order of development as the lateral appendages, appearing as small conical papillæ undistinguishable from them, thus confirming the belief of their homologous nature.

The history of development, in thus showing the original uniformity and homogeneity of the sporiferous appendices and pinnæ, confirms the analogical indications derived from allied genera in a preceding part, as well as the elucidations given—of a gradational metamorphoses of pinnæ into sporiferous appendices—by the teratological specimens; and thus conjointly afford indubitable evidence of the sporiferous appendices being, as Endlicher supposed, modifications of pinnæ; their peculiar morphological conformation being specifically dependent on the amount of adhesion with the rachis; or, strictly speaking, on the non-development of the interpetiolar part—as these appendices do not originate any closer to the pinnæ immediately succeeding, than these do successively each other, the interpetiolar parts being, of course, a subsequent development.

3. *Excerpt from Letter from Mr William Shireess, Chemist and Gold Assayer, Sandhurst, Victoria, Australia, relative to the late Expedition to the Gulf of Carpentaria, with a Notice of the Nardoo Plant (Marsilea quadrifolia ?).* Communicated by Professor BALFOUR.

“SANDHURST, VICTORIA, 25th November 1861.

“The great event of the month has been the news of the discovery of the fate of the exploring party of Burke and Wills, by Mr Howitt, who was sent out as leader of a contingent party to search for the missing explorers. Never was there such a melancholy story told to a sympathising public, as that which Mr Howitt's researches has unfolded. You will see fully by the papers sent all that has as yet been printed; but, by next mail, I shall send supplementary intelligence, which will be as complete as it ever can be. The harrowing facts may be told in a few words. Towards the end of December 1860, Burke, after having established a depôt of provisions at Cooper's Creek (left in charge of Mr Brahe and a few men), started in company of Messrs Wills, King, and Gray, with several camels and horses, and three months' provisions, to try to accomplish the main object of the expedition, viz. crossing to the Gulf of Carpentaria,—a feat, though often attempted, never before accomplished. By the diary of Wills, which is singularly incomplete, you will see, that, finding a glorious, well-watered country all the way, they found the flow of the tide of the sea in Albert River, in February of this year; and, after spending three days upon the shores of the Gulf of Carpentaria, they started to retrace their steps. But, long before Cooper's Creek could be reached, it became evident that food must fall short; and, consequently, they put themselves upon rations just sufficient

to sustain life, and toiled on, having their diet increased and varied by the flesh of their horses, a large snake, &c. The camels, reduced to two, could barely drag themselves along, and were useless as a means of transit; and the worn-out explorers could, with the utmost exertion, only make three miles a day. When within a few miles of the longed for depôt, Gray gave way and died. On the 21st of April, towards evening, they at length reached Cooper's Creek and the depôt; but, alas! alas! found that Brahe had, *that very morning*, started on his way back, with camels and horses in first-rate condition, he having abandoned all hope of their return. They found a tree marked "21st April, Dig." On digging they found that Brahe had left a few weeks' provisions, but no clothing. Being utterly unable to attempt on foot to overtake a party mounted on strong camels and horses, they remained a few days to recruit, and got wonderfully revived. As the nearest point of civilization upon the Melbourne route was Menindie, 400 miles distant, they resolved to try to make a point in South Australia, 150 miles distant. But a toilsome journey of a few days exhausted all their food; and, killing the remaining camels, they "jerked" the meat; and despairing of their own weak laborious efforts accomplishing their deliverance, they sought the assistance of the native blacks, who had from time to time supplied them with fish. The blacks had, in addition to fish, given them some pounded Nardoo seed. Finding they could not support themselves, they wished to live with the savages until help should come, but the blacks had shifted their quarters, and could not be come at. Fortunately King discovered the Nardoo plant, and the collecting and pounding the seed occupied a good deal of their time. Wills was gradually sinking, and was unable to move; and, having placed him in a native wurley (hut), and left a plentiful supply of Nardoo within his reach, Burke and King set off in search of the blacks. Burke's strength however gave way, and he died; and, at his own request, King left him unburied, lying in the wilderness with a revolver in his hand. Such was the end of a gallant man! On returning to where he had left poor Wills, King found that death had claimed him too; and, scooping a hole with his hands, he gave him what burial he could. He then set off alone, and fortunately fell in with a party of blacks, by whom he was most kindly treated, until he was discovered by Mr Howitt's party, and succoured. We had the news in Sandhurst three weeks ago, but King only arrived here on Saturday (23d), and left for Melbourne this morning. An inquiry is being held there upon the subject, and at present the public mind is divided between sorrow for their fate and indignation at the cause of it; the Royal Exploration Committee getting a share of the blame, which justly falls upon Brahe for having deserted his post. Howitt speaks of saving the Nardoo which he found by the bodies of Burke and Wills. King has brought it down; and by favour, I have the pleasure of enclosing two of the seeds for your inspection, and as a relic of this glorious, though ill-fated, expedition. You may prize the seeds more highly in Scotland, when I tell you that I could get double their weight in gold for them. The Nardoo only grows in the far north; and although the natives live upon it, the experience had of it by the explorers, shows that it does not afford the requisite nutriment to Europeans. Mr M'Nab of the Botanical Gardens might contrive to grow the seeds, which will always have an interest attaching to them, although the plant may be common enough by and by.

4. *Paper on Cotton, transmitted by the Agri-Horticultural Society of Madras.* Communicated by Professor BALFOUR.

The Rev. Mr Macfarlane writes to the Madras Government as follows:

—"Much has been done in recent years, and great expense has been incurred, to improve the quality of Indian cotton by the introduction of foreign seed, but comparatively little to improve the indigenous plant (probably *Gossypium obtusifolium*), which, possessing certain acknowledged advantages over exotics, has yet important defects, such as brittleness and shortness of staple, which by improvement in cultivation, but still more in the quality of the seed, may, it is believed, be wholly removed. This may be done first by careful and high cultivation, and continuous and careful selection of the best seed, by which it can be made to outgrow in the course of two or three croppings its present defects, in the same manner and by the same process successfully followed in England, by which cereals and other seeds are improved, and even altered in some of their qualities. Second, by hybridising the indigenous seed with some of the best varieties of foreign countries which possess in the greatest degree those qualities in which the country seed is defective, but which are found difficult to cultivate in India, as for example Sea Island Cotton. If the properties of great length and flexibility of fibre could by hybridising be communicated to the indigenous cotton, a staple would be obtained of great value in the English market."

The following is an extract from a minute by Sir W. Denison :—

"I am induced to bring under the consideration of the Council questions connected with the improvement and extension of the growth of cotton in the Presidency of Madras, by the publication of a resolution of the Governor-General in Council, to the effect that prizes of 10,000 rupees will be given during the years 1861-62, 1862-63 in each of the Presidencies of Fort William, Madras, and Bombay, under certain conditions made known in the proclamation. The subject of the extension of the cultivation of cotton in the British colonies has been under my consideration for many years past. In Australia various attempts were made to introduce the finer species of American cotton, and, so far as the quantity and quality of the cotton were concerned, these attempts succeeded; but the high price of labour was a complete bar to the introduction of cotton as a paying crop. Since my arrival in Madras the same subject has been brought before me in various ways, at one time in the shape of suggestions for the improvement of the means of conveyance by water or railways, for the purpose of bringing more cheaply to market the surplus produce supposed to exist in the interior; at another, as in the present instance, by proposals to stimulate the cultivation by the offer of prizes. I have in consequence been led to make a variety of inquiries from persons engaged in the cultivation of cotton, and from others, and the following are the results to which these inquiries have led :—

"(1.) That the great surplus of cotton supposed to exist in the interior of the country, and which only awaits cheaper means of conveyance to bring it to market, is the product of the imagination of those whose object it is to show that there is traffic sufficient to defray the cost of transport, as well as the interest of money invested in railroads or canals, as the case may be. Cotton is cultivated, and that largely, in various districts; but this is generally done by the ryots under the stimulus of an advance of capital from a merchant or speculator, and on the security of a fixed price per pound for the crop. There is therefore little or no surplus beyond that already, so to say, mortgaged to the merchant, at a price low enough to enable him to pay all costs and charges to the port of shipment.

"(2.) That the extensive districts of what is emphatically called 'Cotton soil,' though well adapted to produce native cotton, which is short in the staple and strong, not to say coarse, in the fibre, is not congenial to the growth of the fine species of American cotton. This kind of cotton I know, from experiments in Australia, to flourish in a light sandy loam,

and I am told that similar results have been obtained here. The 'cotton soil,' which is an adhesive black clay, almost of the consistence of birdlime, when thoroughly wet, dries into the consistence of a brick, but crumbles under the action of the sun and slight showers into a light dry powder. In the dry season this soil cracks deeply, showing, by the amount of shrinkage when the water evaporates, that it contains a very large proportion of clay. The experiments which have been made on the cultivation of the American cotton on this soil have hitherto been unsuccessful. That there are soils in which these cottons can be grown is very probable. In the red soil of Coimbatore Bourbon cotton is grown to some extent, and it is possible that other sites may be found where the Upland or New Orleans cotton may be grown with advantage.

"With a view, then, to the development of the cotton-producing powers of India generally, by which the English manufacturers might be relieved from their present dependence upon the supply from America, two courses appear to present themselves:—

"(1.) The encouragement, by every means, of the introduction of the better species of American cotton.

"(2.) The improvement of the native cotton, by increasing the length of the staple, and lessening the coarseness of the fibre. Attention paid to the last of these two schemes would be likely to yield results more profitable to the cultivator, and more advantageous to the manufacturer, than any which would result from the cultivation of American cotton. In the first place, we know that there is a large extent of soil well fitted for the cultivation of this particular species; that little encouragement will be required to induce the ryots to cultivate it upon the soil; that any rise of price contingent upon the improvement of the quality of the cotton, unaccompanied (as will be the case) with any increase in the cost of cultivation, is to the direct advantage of the ryot, and will do much to stimulate production. On the other hand, the cultivation of the American cotton must be at first an experiment; it is known to be a precarious crop, and the better the quality and the higher the price the smaller is the yield per acre.

"While, however, I am inclined to advocate the improvement of the native cotton as the most profitable crop, I am by no means disposed to check attempts to acclimatise the better descriptions, and I will now proceed to describe, first, the process by which it is probable that the native cotton can be improved, and, secondly, the steps which it would be desirable that the Government should take to encourage a series of experiments in various parts of the country, partly with a view to the introduction of new species of cotton, partly with a view to the improvement of the indigenous species. I must premise that the mode of improving the native cotton has been suggested by the Marquis of Tweeddale, who explained the process to Mr Thomas, the collector of Coimbatore, in a letter which that gentleman communicated to me.

"The process is as follows:—From the seed pods of this year's crop take out those seeds to which the largest fibres are attached, establishing a minimum length of fibre, and throwing away all those seeds the cotton of which does not reach this standard; these selected seeds will be used for the next crop, and a similar process will be followed with this, the minimum length being increased every year. In this way, in the course of a few years it is probable that a permanent addition will be made to the length and possibly to the fineness of the fibre, and it will then be easy to spread the seed of the improved kind over the whole of the indigenous cotton fields of India.

"In the resolution of the Governor-General in Council to which allusion has been made, a former resolution of 28th February is referred to, in which the following principle is laid down: 'That no measure which places Government in the position of the private capitalist, or cultivator,

or which in any way interferes with private enterprise, can be otherwise than permanently injurious in itself and detrimental to the object in view. Therefore all attempts to stimulate cultivation or labour by any exertion of Government authority, directly or indirectly, are out of the question. The same objection will apply to model farms and experimental cultivation conducted by officers of Government.'

"Approving generally of the principle laid down, though perhaps I might demur to some of the deductions if carried out generally, I will now explain the mode in which I propose that the Government should act to encourage the experiments detailed above, as well as those which have for their object the introduction of the better qualities of cotton.

"The object being to improve the quality of the cotton grown on what is called the 'cotton soil,' I should propose to allow to a few intelligent natives in different parts of the country, who may be willing to undertake these experiments, a remission of all assessment upon a certain quantity of land, not exceeding say thirty acres in extent, for a period of five years, upon condition that this land should be devoted to cotton cultivation, and that an annual return should be made to the collector, showing the area under cultivation, the cost of cultivation, the amount of the crop, &c. &c., and that this should be accompanied by a sample of the crop, showing all the varieties of cotton grown.

"In addition to this a reward should be promised to all who, at the end of five years, should be able to show that the produce of their land was superior in value, taking quantity and quality into consideration, to that of similar land under cotton cultivation, and this reward should be made in some measure proportionate to the improvements in the quality of the cotton, whether this be the result of a change in the quality of the native cotton, or of the introduction of a superior species; in fact, it might almost be made proportionate to the price of the cotton sent to market; and as in the present instance the Governor-General in Council has not hesitated to offer a reward of 10,000 rupees in a single prize, I do not think that there ought to be any hesitation in establishing a gradation of prizes varying from 100 to 5000 rupees, according to some scale to be hereafter determined, the highest premium being given to the successful cultivator of cotton, whose value per pound and the value of the crop per acre should not be less than the sums determined on."

5. Remarks on the Polar or Compass Plant. By WM. GORRIE, Esq.

Mr Gorrie remarked that *Sylphium laciniatum* is probably the plant referred to under that name in the "Scalp Hunters," and other popular works. It belongs to the natural order *Compositæ*, sub-order *Tubulifloræ*. It is called also Rosin-weed. Its stem when fully grown is 3 to 6 feet high, leaves very rough, pinnately-parted, petioled, but dilated and clasping at the base. The lower leaves are 12 to 20 inches long, ovate in outline; on the wide open prairies they are said to present their faces uniformly north and south. The heads of the flowers are $1\frac{1}{2}$ to 2 inches in diameter. The plant is found on the prairies of Michigan and Wisconsin, and thence southward and westward. Longfellow, in his "Evangeline," alludes to it thus:—

"Patience," the priest would say, "have faith and thy prayer will be answered.

Look at this delicate plant that lifts its head from the meadow,
See how its leaves all point to the north, as true as the magnet.
It is the compass flower that the finger of God has suspended
Here on its fragile stalk, to direct the traveller's journey,
Over the sea-like, pathless, limitless waste of desert."

Dr Alexander Dickson exhibited a series of microscopical preparations

showing the centrifugal development of the ovules on the placenta of *Primula vulgaris*. Also, a portion of a poppy capsule macerated so as to show the arrangement of the vascular bundles—the strong ribs in the wall of the seed vessel corresponding to the lines of junction of contiguous carpels, and not to midribs as might have been imagined. From these ribs are given off all the smaller vessels of the wall, as well as those ramifying in the placenta to supply the ovules.

Professor Balfour presented for Professor Dickie the following specimens:—*Burbaumia aphylla*, which had been picked in large quantity (upwards of 200 specimens) in the parish of Towie, Aberdeenshire, in July 1861, by Mr Coutts; *Anacalypta latifolia*, from a rocky hammock above the village of Castleton, Braemar; *Orthotrichum arcticum*, from the east side of Davis' Straits, collected by Mr Taylor. Professor Dickie also reported that *Cystopteris montana* had been found in Canlochan Glen, and other places in the Braemar district.

Captain Playfair sent seeds of an undescribed species of *Poinciana*, found at Aden, and which had been named by Dr Anderson of Calcutta *P. Playfairii*. The plant is a very handsome species, with pure white flowers, changing to a pale buff colour when slightly faded.

Mr Archibald Hewan, of Old Calabar, sent specimens of *Scleria Flagellum*. He says: "This sedge, growing to the height of several feet, supporting itself by intertwining upon neighbouring shrubs, may be truly called 'Nemo me impune lacessit,' it catches so speedily upon a very slight contact with it."

Mr M'Nab gave the following report on the flowering of plants in the open air in the Botanic Garden:—*Eranthis hyemalis*, January 16, 1862; *Corylus Avellana*, January 18; *Rhododendron atrovirens*, January 26; *Garrya elliptica*, January 28; *Crocus susianus*, January 28; *Helleborus purpureus*, January 29; *Leucojum vernum*, February 1; *Galanthus plicatus*, February 1; *Crocus vernus* vars., February 2; *Hepatica triloba*, February 7.

Professor Balfour mentioned that Professor Blume, the celebrated Dutch botanist, and an honorary member of the Society, had just died at Leyden, and that Willem Henderick de Vriese, another celebrated botanist, had also died at Leyden, on 23d January last. He had also to record the death of Mr Borrer, the eminent English botanist, and a Fellow of the Society; also that of Mr John Livingston, who had contributed valuable physiological papers to the Society's proceedings.

SCIENTIFIC INTELLIGENCE.

BOTANY.

On the part played by the Mycodermis in Acetic Fermentation. By M. L. PASTEUR.—Naturalists designate under the name of mycodermis those pellicles commonly called scums which make their appearance on the surface of all fermented liquors. One of them deserves especial mention, that, namely, which is sometimes found in vessels which contain vinegar, under the appearance of a membrane, more or less difficult to tear, of a gelatinous consistency, and which has been long known in the language of the manufacturers by the characteristic name of *mother of vinegar*. On this subject Berzelius expresses himself in these terms. "Vinegar," says he, "kept in vessels where it is in contact with the air, loses its transparency; a coherent gelatinous mass gradually gathers in it,

which appears slippery and swelled when it is touched, and from which the liquid that it contains cannot be pressed out. This mass has received the name of *mother of vinegar*, because it was erroneously believed that it was capable of determining the acetic fermentation . . . ; in a state of purity it is destitute of this property, which is entirely owing to the acetic acid which is contained within it." Various practices of the vinegar-makers agree completely with the opinion of Berzelius.

A remarkable fact, discovered in 1823 by Edmond Davy, has exerted great influence on the theory as well as on the industrial process of making acetic acid. Platinum-black moistened with alcohol diluted with water becomes heated, and gives birth to acetic acid. This fact has become the occasion of a new process for vinegar making. Alcoholic liquids are made to flow over beech shavings piled up in barrels in which the air can circulate freely. The shavings, it is said, performs the same service with platinum-black, that of a porous body, which condenses the oxygen of the air. In a word, nothing is more obscure than this vinegar making, entirely abandoned as it is to empiricism and routine

In the researches I have been pursuing for several years on fermentation, several indications had led me to think that the mycodermis might be concerned in the formation of acetic acid. These indications multiplying more and more, I applied all my efforts to follow them by direct experiments.

Of the different mycodermic species, that which is the most easy to cultivate, if I may be allowed the expression, is undoubtedly the scum of wine, the *Mycoderma vini* or *cerevisiae*. It was on it I began my studies. Their first results were directly contrary to what I expected. In causing the scum of wine to form on various alcoholic liquids in contact with the air, I did not obtain any acetic acid at all. Nay, more than this, if I introduced directly into the liquid a certain proportion of this acid it gradually disappeared. It was the same with alcohol. Nevertheless these results were not constant. But what is essential to remark is, that all these facts were subordinated to the presence and life of the mycodermis. I shall return to these apparent complications. But let us consider not the scum of wine, but of vinegar, the *Mycoderma aceti*.

In cultivating this new species, pure and without mixture, on the surface of alcoholic liquids, I ascertained this time, as the general character of the phenomena, that the alcohol always became acetic with the intermediate formation of small quantities of aldehyde. As to the correlation between the manifestation of the chemical phenomena and the presence of the plant it was as rigorous as in the first case.

That being determined, let us repeat the preceding experiments relative to our two mycodermis in close vessels, where we can shut up besides the liquid and the seeds of the plant under experiment, a determinate volume of air, and in such a way that we shall be able at any time to add to the analysis of the liquid that of the atmosphere of the vessel. The understanding of the phenomena then appears in all its simplicity. In fact, it is seen that the mycoderm of the vinegar takes the oxygen of the air and fixes it upon the alcohol, and so makes acetic acid of it, and that the mycoderm of the wine takes equally the oxygen of the air, and fixes it equally upon the alcohol, but so as to make of it the vapour of water

and carbonic acid. It is further seen that, if the alcohol is suppressed, and the mycoderm of the vinegar is made to grow in an acetic liquid, the acid is transformed into water and carbonic acid. With the mycoderm of wine the effect is the same, although there may have been alcohol in the liquid.

Consequently, if we remark that aldehyde is nothing else but alcohol minus hydrogen, that acetic acid is alcohol which has undergone a further combustion, and that, in short, alcohol and acetic acid, when they experience complete combustion, are transformed into water and carbonic acid, we will logically infer from what precedes that the scum of wine behaves exactly like the scum of vinegar, only that there are circumstances in which its properties are exalted,—that is to say, that the plant, instead of taking from the air two or more molecules of oxygen in order to fix them on a molecule of alcohol to make aldehyde or acetic acid of it, seizes on eight or twelve molecules of this gas, and, by their aid, transforms completely the alcohol and acetic acid into water and carbonic acid. And all these facts are accomplished with great force, with a great disengagement of heat, and a rapidity which would astonish the boldest imagination.

Thus we see how the same plant which provokes the acetification of alcohol can destroy the acetic acid which it has formed. We see also how the manufacturer who first called the mother of vinegar *the flower of vinegar*, was guided by a true instinct. We see also how Berzelius, on the other hand, in refusing to the mother of vinegar the power of producing acetic acid because it destroyed that acid, advanced a true fact, of which the interpretation alone was erroneous.

I have ascertained that the scum of vinegar no longer determines acetification when it is submerged. In order that it may act, it is necessary that it cover the surface of the liquid. In the vinegar works those deposits in the tuns, which the manufacturers call *mères*, have no sort of acetifying action. Everything takes place at the surface of the liquid.

In this way I demonstrate these facts experimentally. I determine the acetification of an alcoholic liquid by the aid of the vinegar plant, and in such a way that the frond of the plant may become so strong as to be difficult to break. At the same time, I measure day by day the progress of the acidity of the liquid. Then, at a given instant, I submerge the frond by means of heavy glass rods, which oblige it to fall to the bottom of the liquid. Immediately the acetification is arrested, and it remains so two, three, four, five, six days or more. And as soon as a new frond appears, the continued analysis of the liquid indicates that the formation of acetic acid is renewed. This result proves that the plant does not act by a principle which it could secrete in order to diffuse it in the liquid. It shows, besides, that the cause of the chemical phenomenon which accompanies the life of the plant resides in a peculiar physical state analogous to that of platinum-black. But it is essential to remark that this physical state of the plant is closely bound up with the life of that plant. The following is one of the proofs of this assertion. On the surface of an alcoholic liquid containing essentially phosphates and albuminoid substances, I make the scum of wine grow till the whole surface of the liquid is covered with it. I ascertain day by day that there is a disappearance of alcohol and of acetic acid, if any has been added to the liquid. Then with a syphon I

draw off the liquid which produced the plant, without tearing the frond of the mould—a condition easy to fulfil. Then I substitute for the first liquid pure alcohol diluted with water. The mycoderma (difficultly wet, on account of its oily principles) rises and covers the surface of the new liquid. The little plant has then no more for food but the principles which it can find in itself. Now the experiment demonstrates, in these abnormal circumstances of sickness or of relative death, that the plant which, one moment before in full health, effected the combustion of alcohol and of acetic acid, transforms now alcohol into acetic acid only. This experiment proves that the sick plant does the same thing as the healthy plant, but with less energy.

I come now to the process of acetification by the beech shavings. All authors are agreed on the theoretical explanation of this mode of manufacture. The shavings, say they, act like porous bodies, after the manner of platinum-black. This opinion is altogether erroneous. I am going to show that the shavings have no action by themselves, and that they do nothing but serve as a support for the development of one of the mycoderms, particularly the *Mycoderma aceti*. In fact, let us make alcohol diluted with water to flow over shavings or along a cord, the drops which fall at the extremity of the cord do not contain the smallest quantity of acetic acid; but let us repeat this experiment after having steeped the cord in a liquid on the surface of which there is a mycodermic pellicle, which remains in part on the cord when it is withdrawn from the liquid, then the alcohol, which is then made to flow slowly along this cord in contact with the air, is charged with acetic acid.

If the mycoderms had only the property of being the agents of combustion for alcohol and acetic acid, the part which they play would on that account be worthy of fixing the attention. But I have discovered that this property has an extent of action which opens up a new field of study for physiology and organic chemistry. In fact, the mycoderms can carry the burning action of the oxygen of the air on a multitude of organic matters,—the sugars, the organic acids, various alcohols, the albuminoid substances giving rise in certain cases to intermediate substances, of which I have already discovered several.*

I will yet add, that the property now discussed is found in various degrees in moulds; and everything induces me to believe in the most minute of the infusoria. I have ascertained that one can, by the development of a mould, transform into water and carbonic acid relatively considerable quantities of sugar, without there being left in the liquid the smallest quantity of that substance.

If the microscopic beings should disappear from our globe, the surface of the earth would be encumbered with dead organic matter, and dead bodies of all sorts, animal and vegetable. It is they principally which impart to oxygen its burning properties. Without them, life would become impossible.

After death, life reappears under a new form, and with new properties. The germs of microscopic beings everywhere diffused commence their evolution, and by their aid, and by the strange power which forms the object of this memoir, oxygen is fixed in enormous quantities on the

* It appears to me necessary, in this point of view, to revise all that relates to nitrification.

organic substances which these beings have invaded, and gradually effects their complete combustion.

Permit me, in bringing to a close this too rapid sketch, briefly to characterise the results of this work in another point of view. We have just learned that organised cells exist which have the property of carrying the oxygen of the air upon all sorts of organic substances, burning them completely, with a great disengagement of heat, or arresting them as substances of various compositions. This is the faithful image of respiration, and of the combustion which is its consequence, under the action of these organised globules, which the blood brings, without ceasing, into the cells of the lungs, where they come to seek the oxygen of the air, in order to diffuse it afterwards in every part of the body, with a view to burn there in different degrees the principles of the organism.—*Comptes Rendus*, February 10, 1862.

GEOLOGY.

Tertiary Fossil Fruits found in connection with the Lignites of Brandon, Vermont, United States. By LEO LESQUERREUX.

- | | |
|---|--|
| 1. Carpolithes Brandoniana, sp. n. | 13. Aristolochia curvata, sp. n. • |
| 2. „ fissilis, sp. n. | 14. „ obscura, sp. n. |
| 3. „ irregularis, sp. n. | 15. Sapindus Americanus, sp. n. |
| 4. „ Grayana, sp. n. | 16. Cinnamomum Novæ Angliæ,
sp. n. |
| 5. „ bursæformis, sp. n. | 17. Illicium lignitum, sp. n. |
| 6. „ venosus? Sternb. | 18. Drupa rhabdosperma, sp. n. |
| 7. Carya verrucosa, sp. n. | 19. Carpinus grandis? Heer. |
| 8. „ Vermontana, sp. n. | 20. Leguminosites pisiformis?
Heer. |
| 9. Fagus Hitchcockii, sp. n. | 21. Nyssa complanata, sp. n. |
| 10. Apeibopsis (Cucumites), Heerii,
sp. n. | 22. „ microcarpa, sp. n. |
| 11. „ „ Gaudini,
sp. n. | 23. „ lævigata, sp. n. |
| 12. Aristolochia Ceningensis, Heer. | |

American Journal of Science and Arts, November 1861.

Labyrinthodon.—We have been informed by the Rev. W. S. Symonds of the discovery of the remains of the *Labyrinthodon* in the Keuper sandstone of Pendoeh, Worcestershire. The bones appear to be those of the head, and are similar to the specimens in the Warwick Museum. They occur in a “bone bed,” full of the spines and teeth of a Keuper fish, *Lophodus Keuperinus*.

ZOOLOGY.

Synopsis of a Course of Lectures given at the Museum of Natural History (Paris), in 1850; by M. ISIDORE GEOFFROY SAINT-HILAIRE.

1. *On the Animal Series, and the Parallel Classification.*

(1.) The various zoological types may be reduced to a serial or progressive order.

(2.) The principle of co-ordination of the series resides essentially, not as was vaguely said before the time of Lamarck in the greater or less perfection or complication of organisation, but in its diversification,

specialization and *centralization*, which are at the maximum at one extremity of the series, at the minimum at the other.

Thus, at the top, the beings whose apparatus, organs, and tissues are the most *diversified*, whose functions are the most *specialized*, whose organism is the most *centralized*; at the bottom, the beings whose composition is the most *homogeneous*, in whom the functions are the most completely confounded, and the life, in some sort, *diffused*.

(3.) In the animal series, sometimes the terms succeed each other at very close intervals, occasionally even, without sensible interval; sometimes two consecutive series remain at a great distance from each other.

The series is then neither *regular* nor *continuous*.

(4.) Neither is it *simple*. Often, and even most usually, it is double, triple, or more complex still, successions of terms manifestly analogous being found in two or several groups otherwise distinct. These successions of analogous, or as they would be better called, *homologous* terms in different groups, are what we have named *parallel series*.

(5.) Hence arise double relations which it is important to know and to express. Great attention has always been paid to the *affinities* which unite the *varied types* comprised in the *same group*; the knowledge of the affinities which *bind together* the *homologous types* existing in *different groups*, is not less necessary to the rational conception of the series and to the expression of their natural connections.

(6.) This expression, it has seemed to us, can be given by the new system of classification, known as the *parallel classification*, or classification by *parallel series*, which is on the whole but a very simple improvement on the system usually employed.

Suppose a group *n*, comprising several secondary types which we shall designate by the letters *A, B, C, D, E*.

Suppose another group *N*, holding the relations with the first which we have just indicated, that is to say, of which the secondary types are homologous to the preceding. We shall call them, to express at once the *continued* difference and the homology, *a, b, c, d, e*.

Suppose a third group *n*, giving similarly *a, b, c, d, e*. A fourth *N*, giving *A, B, C, D, E*, and so on.

It is manifest that the expression of the multiplied relations, existing between all these terms will be obtained, if on the one hand, the terms of each series, *A, B, C, &c., a, b, c, &c.*, follow each other without the intercalation of any foreign term; and on the other, if the homologous terms of the various series, *A, a, A, B, b, B, &c.*, are in apposition to each other. The parallel classification satisfies these two conditions by the following combination, simple enough to be seized at a glance :

<i>A</i>	<i>a</i>	<i>a</i>	<i>A</i>
<i>B</i>	<i>b</i>	<i>b</i>	<i>B</i>
<i>C</i>	<i>c</i>	<i>c</i>	<i>C</i>
<i>D</i>	<i>d</i>	<i>d</i>	<i>D</i>
<i>E</i>	<i>e</i>	<i>e</i>	<i>E</i>
<i>F</i>	<i>f</i>	<i>f</i>	<i>F</i> *

* For greater simplicity we have here supposed the four series equally extended, and without gaps. In reality it is scarcely ever so. For example, there might be *A, B, D, E, F; a, c, d, f, &c.* The series are not the less manifestly parallel, only, some terms remain without homologues.

(7.) There exist, so to speak, parallelisms of all degrees. The species of one and the same genus, the genera of one and the same family, often form parallel series; it is sometimes thus (to go no higher) with the classes of the same branch. The word *type* just now employed, may then receive any given value, provided that by *group* is understood a division of the degree immediately superior.

The *parallel classification* has been for eighteen years (in 1850) applied by various authors to the greater part of the branches of Zoology, Anthropology, Teratology, and Botany.

II. Summary of lessons on the question of species.

(1.) The characters of *species* are not *absolutely fixed*, as many have said, still less indefinitely varied, as others have maintained. They are fixed for each species, so long as it is perpetuated in the midst of the same circumstances. They become modified if the surrounding circumstances change.

(2.) In the latter case, the new characters of the species are, so to speak, the *resultant* of two contrary forces; the one *modifying*, is the influence of the new surrounding circumstances; the other *conservative* of the type, is the hereditary tendency to reproduce the same characters from generation to generation.

In order that the *modifying influence* should predominate, in a very marked manner, over the *conservative tendency*, it is necessary, then, that a species should pass from the circumstances in the midst of which it was living, into a new and very different totality of circumstances; that it should change, as has been said, its *surrounding world*.

(3.) Hence the very narrow limits of the variations observed amongst wild animals.

Hence also the extreme variability of domestic animals.

(4.) Amongst the former, species remain generally in the places and the conditions where they are established, or remove from them as little as possible; for their organisation is in harmony with these places and conditions, and would be in disagreement with other surrounding circumstances.

The same characters must then be transmitted from generation to generation.

Circumstances being permanent, species are so likewise.

(5.) Already, however, the permanence, the fixity is not absolute. The gradual expansion of a species on the surface of the globe is, at length, the necessary consequence of the multiplication of individuals. Other causes, of an order less general, may also bring about partial displacements. Whence, especially at the limits of the geographical distribution of the species most extended, arise notable differences of habitat and climate, which, in their turn, lead inevitably to secondary differences of regimen and even of habits. To these various kinds of differences correspond *racés* characterised by modifications in colour and other exterior characteristics, in proportion and form, and sometimes even in internal organisation.

(These races have been arbitrarily considered, sometimes as *local varieties*, sometimes as distinct *species*.)

(6.) Among domestic animals, the causes of variation are much more

numerous and more potent. In a long series of experiments which, though undertaken with a merely practical object, have no small theoretic importance, species of various classes, to the number of about forty, have been constrained, by the intervention of man, to quit savage life, and bend to very different habits, regimen, and climates. The effects obtained have been in proportion to the causes; there have been formed a multitude of very distinct races; amongst them several offer characters equal in value to those by which genera are commonly differentiated.

(7.) The return of many of the domestic races to the wild condition has taken place on various points of the globe: thence, a second series of experiments inverse to the preceding, and furnishing the counter-proof. If domesticated animals are replaced in the circumstances in the midst of which their wild ancestors existed, their descendants, after some generations, resume the characters of the latter. They only assume analogous characters if they are restored to savage life under conditions analogous, but not identical.

(8.) To resume: the observation of wild animals strictly demonstrates the *limited* variability of species.

The experiments on wild animals domesticated, and on domestic animals returned to the wild condition, demonstrate it more clearly still.

The same experiments prove, moreover, that the differences produced may be of *generic value*.

(9.) The truth or error of a doctrine may also always be brought to light by the value of the consequences derived from it.

The *theory of limited variability* may lead to *rational* solutions with respect to questions completely insoluble for the partisans of absolute fixity, or which the latter can only resolve by aid of the most complex and improbable hypotheses.

(10.) It is thus with the fundamental question of anthropology. The common origin of the various human races is *rationaly* admissible in the point of view of variability, and *in this point of view alone*. In order to admit it with us, the partisans of *fixity* have been forced to conclude against their own principle.

(11.) In palæontology, to the theory of limited variability corresponds a simple and rational hypothesis, that of *filiation*; to the doctrine of fixity, two hypotheses equally complicated and improbable, that of *successive creations* and that called *translation*.

According to the hypothesis of *filiation*, the existing animals are sprung from *analogous* animals which have lived in the previous geological epoch. We may, for example, seek the ancestors of our elephants, rhinoceroses, and crocodiles, amongst the elephants, rhinoceroses, and crocodiles of which palæontology has shown us the antediluvian existence.

This hypothesis has been rejected as irreconcilable with the *fixity* of species, because of the specific differences which exist between the ancient animals and their modern analogues. To the simple explanation of these differences by changes taking place, from one geological period to another, in surrounding circumstances, has been preferred the hypothesis of several *successive creations*, and, more recently, that of *translation*. To resume the example quoted above: these two hypotheses

agree in admitting the complete extinction of the ancient species of elephants, rhinoceroes, and crocodiles; but the first replaces them by the elephants, rhinoceroes, and crocodiles of the *new creation*; the second, by the actual species, supposed to be pre-existent, with all their present characters, on some other point of the globe which had remained unknown. Of these three hypotheses, that which springs from the theory of variability is incontestably the most simple and least conjectural. For this reason, it may already be presented as the most probable.

(12.) But it has not alone this advantage over the others.

It can be, and is even now, verified in its application to various particular cases.*

(13.) Moreover, it is confirmed by various considerations, in presence of which it seems difficult to maintain the other two hypotheses. Without insisting on that of *successive creations*, we shall confine ourselves to placing here, in opposition, in two of their consequences, the hypothesis of *filiation* and that of *translation*.

(14.) According to the first, the existing animals should be descended from animals merely *analogous*; according to the second, from animals *similar* to themselves. Now, the preservation of the *same characters at all periods*, would suppose the existence, *at all periods* also, of the *same* surrounding *circumstances*, which is *inadmissible*.

(15.) In the hypothesis of *filiation*, the number of species might vary, becoming greater or less from one geological period to another; for if, at each revolution, there has been an extinction of a portion of the species, those which remain *must* have undergone modifications, various according to circumstances, and which *may* have acquired the value and permanence of specific characters. In the opposite hypothesis, at each revolution, a portion of the species disappears; the others *remain what they were*: they are displaced, but without undergoing organic modifications. Consequently, the extinctions are here *without any possible compensation*. Then, according to this hypothesis, the number of animal and vegetable species must have gone on constantly decreasing; there would be a *progressive diminution*, a depopulation of the globe: the two hundred and sixty thousand animal and vegetable species which, according to the most recent estimations, now cover the surface of the earth, would be but the wrecks of a creation infinitely richer in past times.

Such is the consequence to which the hypotheses of absolute fixity and of translation naturally lead: each will judge how far it agrees with the notions that we possess on the ancient condition of the globe.

(16.) The substitution of the theory of *limited variability* for the hypothesis of absolute fixity renders necessary a new definition of species.

To approach as nearly as possible the definitions most in use, and, for the moment considering only the existing order of things, we shall say:—

Species is a collection or succession of individuals characterized by a combination of distinctive features, the transmission of which is NATURAL, REGULAR and INDEFINITE in the existing order of things.

The possibility of distinction, the natural and regular transmission,

* Which has been demonstrated in the Course of Lectures of 1847.

stability, and permanence, equal those of the present condition of the globe—such are the three essential elements of this definition of species.

A few words are necessary to explain the terms of it.

Hybrids are not generally unfruitful, as has often been said;* they can transmit their characters, *always mixed*. Hybrid races are not propagated with the constancy and regularity observed in species; they soon die out, or return by the effect of crossing, to one of the species whence they sprung. The transmission is then neither *regular* nor *indefinite*.

It is the same with monstrous or anomalous races.

Domestic races approach much more nearly to species. Amongst those which are very ancient, and which have thus acquired a great fixity, the transmission may even be said to be *regular*; it may be *indefinite*, and as durable as the existing order of things, but only by the intervention of man, which is necessary to maintain the races as it was to create them. The transmission is not then natural.—*American Journal of Science and Art*. Nov. 1861.

MISCELLANEOUS.

Glaciers in New Zealand.—Mr Julius Haast has recently published a "Report of a Topographical and Geological Exploration of the Western Districts of the Nelson Province, New Zealand," undertaken for the Provincial government. He states that being under engagement to survey the Southern Alps of that country, a magnificent mountain chain of an altitude of 11,000 to 13,000 feet, and covered with perpetual snow, from which, in every direction, glaciers descend, he thought it his duty to reserve the name of Forbes for the first mountain from which he should find a glacier descend, intending thus to name it after one to whose labours science owes so much in the investigation of those beautiful phenomena. Ascending the Rangitata, and following the southern source branch, he had the pleasure of seeing before him a most magnificent mountain chain, the rugged snow-covered peaks of which projected high in the deep-blue sky of New Zealand. The sides were everywhere covered with glaciers, from the icy caverns of which rushed turbid streams which, uniting, soon became a considerable river. He called the mountain chain the Forbes Range, the principal glacier the Forbes Glacier, and the stream the Forbes, in testimony of his gratitude for the manifold instruction which he had obtained from Principal Forbes' works. His friend and companion, Dr A. Sinclair, who was drowned a few weeks afterwards in the Rangitata, was with him when he named the mountain, and assisted him in his researches, having taken the botanical department. The investigation of the Southern Alps is a most pleasing task, presenting numberless points of the highest geological interest, of which Mr Haast will treat fully in a report which he purposes writing next year.

The Livingstone Expedition.—Letter from Bishop Mackenzie.—Mozambique is the smallest of the four islands which are called the Comoro Islands. Its extreme length is fourteen miles and breadth eight. The highest point seems to be 3000 feet. It is covered with verdure, which is always fresh; and plenty of tropical trees, coco-nuts, baobab, and others, occupy the steep sides of its valleys, and cover even the tops of the ridges. It

* We have given proofs of this that cannot be refuted, by uniting in two tables the indications relative to hybrid Mammifers and Birds, and to their products.

is governed by a queen, whom we saw yesterday. We rowed in one of the ship's boats four or five miles, and came in sight of the town after rounding a projecting low point. Our eyes were at once arrested by a wall about twenty feet high, pierced for guns (forty in number), which we found, on closer inspection, to be mere rubblework—the stones not much larger than one's head, built with lime and mortar—and, as our companions told us, far more efficient than any Portuguese fort they had seen on the mainland. We were guided through a strong gateway in one of the side walls into a court, where there were two small cannon—I suppose pieces of horse artillery. At the further end was the door of the hall of public business, which we entered, and passed up between two rows of men who were sitting on the side benches. The hall may have been ten feet or twelve feet wide, and four or five times as long, lighted by high windows on one side, opening into the court. Our guide introduced us to a sallow-faced elderly man, dressed in a long white shirt, with a fine white scarf round his shoulders, and a turban. This turned out to be the second minister of state. Soon a younger, stouter, more cheerful-looking man entered; the whole assembly rose; he seated himself next the minister; we four—Livingstone, Rowley, Kirk, and myself—sitting at the head of the opposite side. This man turned out to be in no way connected with the state, but only a merchant from the neighbouring island of Johanna—a man, however, of considerable influence and esteem in that island. He acted as interpreter, and asked us what we wished. We named our wants, on which the second minister at once acceded, named the price, and referred us to a special officer (? the Minister for Foreign Affairs), whose duty is to interpret for strangers, and see that they get what they want. They asked who we were, had heard of Nyassa, could not remember the name Killimane, and finally asked if we should like to see the Queen. We went up a flight of wooden steps, partly hidden, at the upper end of the hall, and entered by a trap-door to the equal-sized room above; at the farther end was a Turkey carpet, with eight arm-chairs on both sides, facing each other, and the Queen seated at the top, and looking down the room. We made our bows and sat down. She was enfolded in broad scarfs (say half-yard wide) of rich cloth of silk and gold thread, and had on her face a Mohammedan ornament hiding her visage from the middle of the nose to the middle of the chin; she had bright black eyes, and the elder of her two sons, a boy about four years old, sat in his nurse's lap beside her. She seemed to take some interest in our affairs; asked if Rowley and I were brothers (it is not the first time it has been asked); was surprised at Dr Livingstone having spent so many years alone in Africa; asked if he had not been afraid, on which he turned to one of his Makololo, who were at the audience and returned to the Queen his answer, that if a man comes to their country quietly he need not be afraid; but if he comes to hurt them, or steal their things, they will soon frighten him. We had sherbet served in common English tumblers, and sugar-water, scented with rose-water apparently. Dr Livingstone had brought some velveteen and a piece of shawl pattern as a present, but gave it to the prince rather than to so fine a lady. On leaving, we were invited by our Johanna friend to his house, and immediately after up came two Frenchmen, a priest and a layman, of whom we had heard.

We promised to visit their cottage when we left our earlier inviter. He told us when we were quietly in his house, that the Mohella people were afraid of these Frenchmen, and would be glad to be rid of them, that they would like to have an English consul like Johanna, but that the ministers of State would speak to us about it. The first minister was not well, and while they went to arrange for our seeing him, we paid our visit to the Frenchmen. They did not seem to be doing much. The farmer had not begun to cultivate, nor the priest to preach or try to convert. They had been here three months, and had come from Madagascar. On leaving them we were led to the house of the first minister, a stouter, more genial-looking man than the second, though there was an earnestness and look of truth and strength of character about both.—*The Guardian*.

PUBLICATIONS RECEIVED.

1. Proceedings of the Literary and Philosophical Society of Manchester. January and February 1862.—*From the Society*.

2. Vis Inertiæ Victa; or, Fallacies Affecting Science. By JAMES REDDIE.—*From the Author*.

3. Journal of the Chemical Society for January 1862. *From the Society*.

4. American Journal of Science and Arts, for November 1861.—*From the Editors*, with the following notice:—

To the Patrons of the "American Journal of Science," and the Friends of Science in the United States.

Cut off by the exigencies of the times from a large number of our subscribers—residents in disloyal States—and participating in the inconveniences consequent on the general derangement of public affairs, the Proprietors of this Journal trust they may be permitted to express to their subscribers and to the friends of Science generally, the hope that they will in all cases renew and continue their subscriptions to the AMERICAN JOURNAL OF SCIENCE for the ensuing year.

Claiming the privilege of bearing cheerfully our share of the present demands on all patriotic citizens, our hope is to receive such a measure of co-operation from the friends of Science as will enable us to sustain with credit the public trust so long, by their indulgence, committed to our hands. This co-operation we look for not only from those whose names have long been on our lists; but from many others also who may desire thus to testify their good will to the cause we represent.

SILLIMAN & DANA,
Proprietors of the Am. Jour. Sci.

NEW HAVEN, CT., November 1st, 1861.

Abstract of the Meteorological Register for 1861, kept at Arbroath, by ALEXANDER BROWN, Honorary Member of the Literary and Philosophical Society, St Andrews; Observing Member of the Scottish Meteorological Society, &c.

Latitude 56° 34' N. Longitude 2° 39' W. Distance from the Sea, 4½ of a Mile.
Height of the Barometer above the Sea, 76 feet; height of the Thermometer from the ground, 11 feet, and of the Rain-Gauge, 2 feet.
The number of "Rainy Days" includes those on which snow or hail fell.

1861.	BAROMETER.		THERMOMETER.							HYGROMETER.		WINDS, AT 8½ A.M.													
	Corrected to 32°, and reduced to sea-level.		84 A.M.	72 P.M.	Mean.	Mean Max.	Mean Min.	Mean.	Spring Water.	Days Thier. below 32°.	Rain in Inches.	Mean Dew Point.*	Degree of Humidity (complete Sat. 100).	Fair Days.	Rainy Days.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	Total.
	9th. A.M.	5th. P.M.																							
January, . . .	29.96	29.97	36.1	36.7	36.4	41.0	33.2	37.1	48.0	11	1.754	32.3	0.677	21	10	3	—	2	5	5	—	6	8	2	31
February, . . .	29.62	29.63	38.5	38.7	38.6	44.4	35.7	40.0	47.2	8	1.724	34.7	0.78	16	12	3	—	2	3	4	5	4	4	3	28
March, . . .	29.45	29.45	40.7	40.5	40.6	48.3	38.6	44.0	45.7	2	1.934	33.8	0.81	14	17	1	—	1	3	4	2	5	14	1	31
April, . . .	30.12	30.10	45.5	45.7	45.8	52.7	39.4	46.0	46.0	3	1.949	37.5	0.758	22	8	4	—	4	1	1	3	7	6	3	31
May, . . .	29.92	29.92	50.8	50.8	50.8	57.8	42.3	50.0	46.3	3	1.947	41.0	0.708	21	9	3	4	1	8	—	4	1	2	6	30
June, . . .	29.92	29.90	56.8	57.5	57.1	62.8	50.8	56.8	47.5	—	2.528	50.0	0.819	21	9	3	4	1	8	6	4	1	2	6	30
July, . . .	29.58	29.58	58.8	60.0	59.4	66.2	51.1	58.7	47.7	—	2.561	53.0	0.795	17	14	1	2	—	3	9	7	4	3	3	31
August, . . .	29.72	29.72	59.0	58.7	58.9	66.1	52.8	59.4	48.3	—	4.787	53.0	0.819	16	16	2	—	1	7	6	1	5	4	3	31
September, . . .	29.66	29.65	54.8	54.0	54.4	61.7	50.0	55.8	49.0	—	4.238	48.9	0.843	11	19	3	—	3	4	3	4	5	4	3	30
October, . . .	29.82	29.85	49.2	52.8	51.0	55.8	45.6	50.5	49.0	—	1.979	45.1	0.858	21	10	8	—	1	4	6	3	4	5	3	31
November, . . .	29.45	29.45	38.2	38.6	38.4	43.6	34.1	38.8	48.0	12	3.511	33.0	0.841	21	13	5	1	1	2	3	4	3	2	3	30
December, . . .	29.97	30.03	36.0	36.8	36.4	41.6	33.9	37.7	47.5	12	2.904	33.5	0.923	17	10	3	—	2	2	2	2	4	9	8	31
Mean, . . .	29.77	29.77	47.1	47.5	47.3	53.4	42.1	47.7	47.5	50	29.856	41.5	0.881	218	147	31	8	21	42	45	31	64	74	49	365
Do. 1860, . . .	29.72	29.72	44.3	44.1	44.3	50.8	39.2	45.0	47.8	104	30.475	38.7	0.823	216	150	29	12	51	37	18	27	55	92	45	346

For twelve years the average daily temperature at 8½ A.M., at 7½ P.M., and the mean of the daily extremes, are as follows, viz.:

8½ A.M. 7½ P.M. Mean of Extremes.

Barometer at 8½ A.M. was highest on 27th December, 30.50, and lowest on 18th March, 28.77. Wind N.W.

Do. at 8½ P.M. was highest on 27th December, 30.50. Wind N.W.

Do. do. was lowest on 17th March, 28.62. Wind S.

Thermometer at 8½ A.M. was highest on 20th June and 4th August, 64° 5. Wind S. and S.W.

Do. do. was lowest on 4th January, 29° 5. Wind N.

Do. at 7½ P.M. was highest on 14th June, 67°. Wind calm.

Do. do. was lowest on 4th January, 21°. Wind N.

Thermometer in night, highest, 11th and 27th August, 57° 5; lowest, 5th January, 19°.

Thermometer in day, highest, 28th June, 19th July, 10th and 27th August, 72°; lowest, 4th January, 37°.

Coldest day, 4th January, when average of thermometer was 23° 7 for day and night.

Hottest day, 27th August, when average of thermometer was 64° 7 for day and night.

Coldest month of the year, January; hottest, August.

Wettest month of the year, August; driest, May.

Mean temperature of the year, 47° 5 degrees.

Mean temperature of eighteen years, 45.731 degrees.

The average temperature of the six months of chief vegetation, viz., those from April to September inclusive—for twelve years, is as follows:—

1850 ... 51° 7 1857 ... 53° 0 1864 ... 53° 6 1866 ... 53° 9 1868 ... 53° 3

1861 ... 53° 0 1863 ... 53° 4 1865 ... 52° 1 1867 ... 54° 7 1869 ... 52° 9 1871 ... 52° 2

* The dew-point thus found is obtained from observations of the Wet and Dry Bulb Thermometers, and deduced by Mr. Glaisher's Hygrometrical Tables. The observations of the Wet and Dry Bulb Thermometers are made daily at 8½ A.M. The times of observation of the instruments stated in the Tables are Greenwich mean times.

† The highest and lowest readings of the Barometer are reduced to sea-level, and otherwise corrected.

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END OF VOLUME FIFTEEN—NEW SERIES.

EDINBURGH: PRINTED BY NEILL AND COMPANY.

THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE
PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE
SCIENCES AND THE ARTS.

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JULY OCTOBER 1862.

VOL. XVI. NEW SERIES.

EDINBURGH:
ADAM AND CHARLES BLACK.
LONGMAN, BROWN, GREEN, & LONGMANS, LONDON.
MDCCCLXII.

PRINTED BY NEILL-AND COMPANY, EDINBURGH.

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THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

On the Farinaceous Grains and the various kinds of Pulse used in Southern India. BY WALTER ELLIOT, Esq., Wolfelee.*

The specimens on the table exhibit a series of the cereals and pulses of Southern India, used as articles of food. They were taken from the Madras Exhibition of 1857, and number 107 sorts.† It was intended that the series should embrace samples of every kind of grain or pulse exhibited; but unfortunately it was not discovered until after the collection was dispersed, that a large number of the dry grains had been omitted. The series of wet grains is tolerably complete, comprising 107 varieties of paddy or rice, with the husk. The terms *wet* and *dry* grains are employed conformably with their signification in common language in India, the former referring to grain raised by means of irrigation, the latter to such as are cultivated without artificial watering. These distinctions, however, are only to be understood as generally correct. The paddy or rice crop is the principal wet grain, and cannot be raised without a constant supply of water; nevertheless, it is sometimes grown at higher levels than those to which the artificial systems of irrigation convey water. Such crops are called *maniveri* in the south, and depend on the falling rain alone. They, in consequence, often fail, or yield only a scanty and inferior crop. On the other hand, patches

* Read before the Botanical Society of Edinburgh 13th February 1862.

† The specimens have been placed in the Museum at the Botanic Garden, Edinburgh.



of dry grain, such as *rági* (*Eleusine Coracana*, Gærtn.) or *chólam* (*Sorghum*), are raised by water drawn from wells in the hot weather, to serve as fodder for cattle. But these exceptions are too trifling to affect the general accuracy of the conventional terms in common use.

It may be well to premise, that the seasons in India, as in all tropical climates, are but three:—1. “The monsoon, or rainy season,” commencing in May or June, and lasting four months; 2. “The cold season,” occupying the succeeding four months, to September or October; and the remaining four months constituting, 3. “The hot season.” The first is the period of cultivation, and answers to our spring and summer, which, owing to the rapidity of tropical vegetation, are compressed into one; the second is the time of harvest or autumn; and during the last, which answers to our winter, the land has rest, and vegetation is suspended.

Considerable variation occurs in the dates at which these well-marked alternations of season occur, dependent on the phenomena which regulate the course and progress of the monsoons. The greater part of India comes under the influence of the south-west monsoon; and although the north-east monsoon is not without a certain degree of importance, it is only experienced to an appreciable extent on the coast of Coromandel. The theory of the monsoons is well explained by Mountstuart Elphinstone in his account of the embassy to Cabul. He describes the western trade-winds as commencing in the month of May with violent thunderstorms, and bringing with them the heavy clouds surcharged with moisture impending over the Indian Ocean. In their progress to the eastward they strike on the western shores of the continent, where, deflected from their regular course, they follow the mountain system of India, and, travelling gradually northwards from Cape Comorin to the Himalayas, send off detachments in the direction of the various spurs and transverse ranges which cross the peninsula, till they reach the great northern barrier, where they separate finally into two divisions to moisten the arid plains of Bengal and the valleys of Afghanistan. The time occupied by this process is from six weeks to two months. The first clouds break on Cape Co-

morin about the middle of May. The more distant valleys of Cabul do not receive their supply till July.

The absence of lofty mountains in the Carnatic excludes the lands of the south-east portion of the peninsula from sharing in the benefit of this monsoon, and the want is supplied, but in more scanty measure, by the north-eastern monsoon, which does not begin till October, and is experienced for about two months only. The cause of this partial distribution is apparent at once, from the relative position of the land and sea on the Coromandel, or eastern, and the Malabar, or western coasts. When the east trades begin to blow, they expend their force on the countries lying far south of the Indian peninsula, and deluge the lands of Siam, Burmah, and the Malayan peninsula, so that India gets but the tail as it were of that monsoon. On the other hand, the accumulated evaporation of the Indian Ocean is discharged at once on the coast of Malabar, which is the first land it encounters. Hence the average fall in Western India is from 150 to 200 inches, and at Moulmain, in Pegu, from 200 to 250, while at Madras it is only from 40 to 45.

Notwithstanding this disadvantage, Madras is essentially a rice-producing country, the cultivation of dry grains being much less in proportion throughout the greater part of the southern districts, while they predominate on the table-land above the Ghats. Hence the southern provinces have always been remarkable for the vast amount of hydraulic science employed to secure the means of cultivation. The great dams across the principal rivers, and the enormous embankments raised to intercept the natural drainage of the country, with their subsidiary systems of canals of distribution, are not surpassed either for magnitude* or skill by the public works of any part of the world. These are mostly constructed on the Cáveri, Tungabhadra, Vygey, Támbrapurni, and other southern rivers, and serve as monuments of the wise munificence of early Hindu kings. But of late years they have been emulated by the persevering advocacy and science

* The Chambrambakam Tank, close to Madras, is 15 miles in circumference; the Craveripák Tank, in Arcot, is 30 miles; the dam of the Ponéri Tank, in Tanjore, is 40 miles long, but is now out of repair.

4 Mr Walter Elliot on the *Farinaceous Grains* and the

of a modern English engineer; and to Sir Arthur Cotton we owe important accessions to the Cáveri Works, and a magnificent dam across the Godaverí, 4 miles in breadth, with its dependent system of channels and canals, serving both for purposes of cultivation and navigation. A glance at the map of any of the southern districts, as portrayed in Arrow-smith's Great Atlas of India, in which almost every village and tank is noted, will show the immense importance of these reservoirs in which the superfluous water is stored, which would otherwise be absorbed or carried off to the sea; and hence the solicitude with which the progress of the periodical rains is watched by all classes, who feel that plenty or famine depend on the bountiful or scanty supply of the year.

I. WET GRAINS.

As soon as the monsoon begins the fields are divided into numerous beds by raised earthen bounds, and are well moistened and converted into liquid mud. Into this the rice-plants, which have been previously sprouted in nurseries similarly prepared, are transplanted, and are then submerged in water, which is added freely to compensate for evaporation, so that the roots of the plants are always kept covered until the grain ripens.

The long period during which rain continues to fall, and the rapidity of vegetation, enable the Indian farmer to raise three crops, not, however, on the same ground, although with fields immediately under tanks a second crop is generally taken off the land that had already yielded a first crop.

These three sowings are called by various names; but in the principal language of the south they are distinguished as the—

<i>Tamil.</i>	<i>Telugu.</i>	<i>Muhammadan.</i>
Kár.	Punása.	Túsi.
Samba.	Pedda-panta.	Khariff.
Peshánam.		Rabia.

And are sown, the 1st in June; the 2d in July–August; and the 3d in September–October.

This accounts partly for the many varieties of paddy which the ryots recognise by different names. One exhibitor sent one

hundred and ninety varieties from Tanjore to the Madras Exhibition of 1857, another sent sixty-five from Travancore, fifty were received from Chingleput, forty-four from Pághat, &c.*

Most of these on the table were selected from the Tanjore collection, and are classed as follows:—

Oryza sativa, Linn.

Dhānyam ; Vrihi (paddy)—*Sanscrit*.

Nívāra (wild variety, from *ni*, before, and *vri*, to be)—*Sanscrit*

Tandul† (rice, husked paddy)—*Sanscrit*.

Nel, Nellu (paddy)—*Tamil*.

Arisi (rice, husked paddy, hence the English word)—*Tamil*.

Vari, Vadla (paddy)—*Telugu*.

Nivvari, Nívāramu (wild variety)—*Telugu*.

Biyyam (rice or husked paddy)—*Telugu*.

Kār Series or Early Kinds.

- | | |
|------------------------|------------------------|
| 1. Anantādi-kuruvai. | 26. Muttu-kuruvai-kār. |
| 2. 'Arayan. | 27. Perung-kār. |
| 3. Aruvatan-kodai. | 28. Sendi-kār. |
| 4. Aruvatānāl-kuruvai. | 29. Sengalāni-kār. |
| 5. Anātāna-kuruvai. | 30. Segappu-katalai. |
| 6. Chitra kār. | 31. Sen-kār. |
| 7. Chittriyan. | 32. Siluvai-kadapa. |
| 8. Kār. | 33. Singini. |
| 9. Kalyirāyan. | 34. Sura-kuruvi. |
| 10. Kadapa-kālandai. | 35. Vella-kuruvai. |
| 11. Kadapa-kār. | 36. Vushi-kutalai. |
| 12. Kāru-vélan. | 37. Vella-kadapu. |
| 13. Karun-kuruva. | 38. Vella-kutalai. |
| 14. Kāruttu-kadapa. | 39. Vella-kār. |
| 15. Kāt-alivannan. | 40. Vella-sendi-kār. |
| 16. Katalai. | 41. Vella-kuruvi-kār. |
| 17. Kāt-uppu-vannan. | 42. Yellan-kār. |
| 18. Katti-kār. | |
| 19. Kombu-kuruvi-kār. | |
| 20. Kósu-katalai. | |
| 21. Kurun-kār. | |
| 22. Kuruvi-kār. | |
| 23. Manavari-kār. | |
| 24. Muttu-kār. | |
| 25. Muttu-kuruvai. | |

Samba Peshānam.

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|-------------------------------|
| 43. Atyūr-samba. |
| 44. America (Carolina) samba. |
| 45. Anantān-samba. |
| 46. Alagiyavannan. |
| 47. Bangāla-samba. |

* Wilson, in the Sanscrit Dictionary voce *vrihi*, says there are eight kinds enumerated by the native authorities, but the varieties are more numerous.

† The terms *tandul* and *arisi* signify properly any grain stripped of its husk, but they are applied, *par excellence*, to rice as the predominating kind.

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|------------------------------|---------------------------|
| 48. Garudan-samba. | 76. Palani-samba. |
| 49. Irakku-samba. | 77. Pumbalai. |
| 50. Irangi-muttán. | 78. Péshánam. |
| 51. Jiraga-samba. | 79. Parun-jirkini. |
| 52. Kadai-kál-uttán. | 80. Perum-molagu. |
| 53. Kai-vér-samba. | 81. Ponga-samba. |
| 54. Kál-adichán. | 82. Pál-kadukai. |
| 55. Kálundai. | 83. Ramnánádan-samba. |
| 56. Kambalai. | 84. Sárupáli-samba. |
| 57. Kambam-samba. | 85. Seguppu-sáru-mániyam. |
| 58. Kártika-samba. | 86. Sevan-samba. |
| 59. Karuppu-peshánam. | 87. Sambali-periyan. |
| 60. Karuttu-kalundai. | 88. Seguppu-samba. |
| 61. Kási (or Benares) samba. | 89. Sukha-das-samba. |
| 62. Kattúr-samba. | 90. Sambálai. |
| 63. Káttu-kálundai. | 91. Sáda-samba. |
| 64. Kingani-malai. | 92. Seguppu-molagu. |
| 65. Kodu-válai. | 93. Tilla mayagam. |
| 66. Krishna-lilai. | 94. Tovarai-samba. |
| 67. Kunkuma-samba. | 95. Vella-séru-mányam. |
| 68. Kuruvai-molagu. | 96. Vengu-samba. |
| 69. Muttu-samba. | 97. Vella-molágu. |
| 70. Molagu-samba. | 98. Vella-samba. |
| 71. Ottadam. | 99. Ventya-samba. |
| 72. Pan-móharan. | 100. Váda-samba. |
| 73. Pattu-samba. | 101. Vásanai-samba. |
| 74. Patna-samba. | 102. Vúshi-samba. |
| 75. Pushpa-samba. | 103. Yogal. |

Several of these exhibit well-marked variations of form, colour, &c. ; but doubtless many of them are mere local names, by which the same variety is known at different places.

Besides the cultivated varieties there is a wild kind, which grows spontaneously on the banks of tanks ; but whether it is the progenitor of the numerous kinds of rice now in cultivation, or whether it springs from the accidental scattering of the domesticated grain, it is impossible to tell. Certain it is, that it occurs with uniform characters in all parts of the country. Roxburgh apparently entertains no doubt on the subject, and describes the typical *Oryza sativa* from the wild kind, observing in a note that the trivial name is an improper one "for the original wild plant, which is never cultivated ; however," he adds, "as custom has established it for the numerous varieties thereof, I cannot well attempt to alter

it, in describing what I take for the original wild stock, from whence all the cultivated varieties have sprung." (*Flor. Ind.*, ii. 200.)

The rice obtained from this wild sort is highly esteemed, and is carefully gathered. It is small, very white, and is considered so easy of digestion that it is much recommended for the diet of the sick. In the Azimgurh district of Bengal it is called *tenni*, and there, too, is stated to be much prized.

II. DRY GRAINS.

Of dry grains there are only forty-five specimens,—a series far too small to afford an adequate conception of the numerous varieties recognised by the Indian farmers. They consist of,—

1. Chólam or Jawári—*Sorghum vulgare*, Pers.
2. Bájra or Kambu—*Penicillaria spicata*, Willd.
3. Rági—*Eleusine Coracana*, Gærtn.
4. Tenai or Kangni—*Setaria italica*, Kth.
5. Sámi, Sávi, or Káda-kanni—*Panicum miliaceum*, L.
6. Varagu—*Paspalum scrobiculatum*, L.
7. Pilarisi—*Cynosurus ægyptius*, L.
8. Pul varagu—*Panicum colonum*, L.

1. *Sorghum vulgare*, Pers.; *Andropogon Sorghum*, Roxb.
(Great Millet).

Yavanála	} Sanscrit.	Jonna, Jonnalu—Telugu.
Rakta khurnah		Jowar, Jowári, Jári—Hindi.
Chólam—Tamil.		Durra—Arabic.

Of *Sorghum* there are only two specimens, but they represent the two chief varieties, viz., the red and the white Jowári, —the red forming the early, the white the later crop. The varieties exhibited in 1857 were fifty-six.

It is generally known as Great Millet among the English, as *chólam* in the south, and as *jowári* in the north, and is certainly the staple dry grain of India, and, indeed, of all the tropical countries of Asia and Africa. It extends even into the temperate zone, and is largely cultivated in Europe, in the countries bordering the Mediterranean. It is also grown in the United States,—where it has attracted atten-

tion from its saccharine properties, and in Peru, and other parts of South America. I have seen it in all parts of India, in Arabia, Abyssinia, Egypt, Asia Minor, Turkey, and Italy; and it probably has a range nearly as extensive as wheat, the most widely diffused of all the cereals. The grain forms the principal article of food among the agricultural classes on the table-lands, as rice does of those below the Ghats; and the straw, under the name of *karbí*, affords an admirable forage for horses and cattle.

Its Sanscrit name indicates a foreign origin, *yavana* being the general term for a Greek, Mohammedan, or other stranger; but the Persians call it *Jowár-i-Hindi*, showing that it came to them from India. The Italian name, *Sorgo*, has been adopted for the genus.

In 1856 considerable attention was given to a variety of Sorghum, introduced into Madras from South Africa under the name of *Imphi*, with supposed saccharine qualities, of sufficient importance to supersede the sugar-cane in the manufacture of sugar.

The subject was carefully investigated by M. Perottet, a well-known botanist of Pondicherry, to whom a series of specimens of the grain obtained from the Cape of Good Hope was sent. He raised plants from all of them, and identified them as the *Andropogon cafrorum* of Kunth (*A. saccharatus*, Roxb.), and, after subjecting the produce to various experiments, he came to the conclusion that they were not suited to the manufacture of sugar. "It must be a matter of surprise," he observes, "that although these plants have been known for upwards of a century, no one has hitherto tried to turn them to account, with reference to their saccharine properties. Is it because this sugar, which is found in the plant in the state of *glycose*, is difficult to extract and difficult to obtain in a state of perfect crystallisation? This is the only conclusion we can come to, and in it we must include the Chinese Sorgho of M. Montigny (*Andropogon niger*) which has been equally well known for a long time." He farther adverted to the difficulty of cultivating it for sugar, on account of its liability to be laid by wind and rain; and the juice itself, when compared with that of *Saccharum officinarum*, he describes as "more

insipid, thinner, the impression on the organs of taste evanescent, and more fit for conversion into rum than sugar."

I have always been of opinion that all the different kinds of Sorghum found in cultivation were nothing more than varieties occasioned by domestication of the normal type of *Sorghum vulgare*; and, in a report I was asked to prepare on M. Perottet's paper by the Horticultural Society of Madras, I made the following observations:—

"Seven species of Sorghum are enumerated by Kunth, viz.:—

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|--------------------------------------|--|
| 1. <i>Andropogon Sorghum</i> , Brot. | 5. <i>Andropogon rubens</i> , Kunth. |
| 2. <i>Andropogon niger</i> , Kunth. | 6. <i>Andropogon saccharatus</i> , Roxb. |
| 3. <i>Andropogon cernuus</i> , Roxb. | 7. <i>Andropogon caffrorum</i> , Kunth. |
| 4. <i>Andropogon bicolor</i> , Roxb. | |

Of these, Sprengel pronounces No. 2 to be a mere variety of No. 1, and No. 7 a variety of No. 6. We have seen that M. Perottet arrived at a similar conclusion.

Persoon considers Nos. 4 and 5 to be varieties of No. 1; and Willdenow admits the latter, or No. 5, to hold only an intermediate place between Nos. 1 and 6.

Lastly, Roxburgh, in describing No. 3, speaks of it doubtfully as a species, and thinks it may be a variety of No. 1.

Thus, in the opinion of distinguished botanists, the group is reduced to two species:—

1. *Sorghum vulgare*, Pers.—*a. nigrum*; *β. bicolor*; *γ. rubens*; *δ. cernuum*.
2. *Sorghum saccharatum*, Pers.—*a. caffrorum*.

Now, if we contrast the descriptions of these two, we find there is little difference between them save in the denseness or laxity of the head, the glumes being smooth or more or less clothed, and the presence or absence of an awn.

None of these, I apprehend, can be admitted as characterising a specific difference.

With regard to the first point, I can state with confidence, from my own observation, that characters derived from the density or otherwise of the head cannot be relied on.

I had occasion to make a careful examination of the Sorghum crops in the Rajahmundry district in 1853, in the

course of which I passed through a succession of fields, from the rich, deep, alluvial *lanka** lands in the islands of the Godaveri, to the shallow, stony soils on the uplands, exhibiting every shade of appearance, from the large, dense, coarctate head to the lax panicle, the branches of which were sometimes upright, sometimes drooping, the colours varying from pure white through every shade of yellow, pink, red, and brown, to black, the height varying from three feet to thirty feet.

A large head, not selected, but taken at random from a *lanka* field, contained 5618 corns, and weighed 10½ oz.

A head from an intermediate field contained 3856 corns and weighed 4 oz.

The average heads of the upland fields were not half the size of the last. Many were even smaller.

Sorghum vulgare is the early *jowári* of India; *S. saccharatum* the late. *S. cernuum* is described from the kind cultivated in the mountain districts of Eastern Bengal. *S. rubens* is sown indifferently with *S. vulgare* as an early crop, and is distinguished from it only by its colour. *S. cafrorum* is an African variety from the Cape of Good Hope, and *S. niger* from China. *S. bicolor* is so called from the black and white coloration of the glumes, but it appears to be merely a variety of *S. vulgare*.

None of these have been seen save in a state of cultivation, and I feel convinced that if many of the other varieties I have seen were laid before a chamber botanist, they might be considered by him entitled to rank as species.

On these grounds I consider that *Sorghum vulgare* should be alone recognised as a good species, and that all the other cultivated kinds should be reduced to varieties of that as the normal type.

The varieties enumerated in the Madras Exhibition of 1857 were the following:—

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|-------------------------------|------------------------------|
| 1. Common red <i>jowári</i> . | white kind from Chingleput |
| 2. Common white do. | and Canara. |
| 3. Common yellow do. | 5. Shenchólam.—A red variety |
| 4. Alangkáru.—A small milk- | from Tanjore. |

* The Telugu term for alluvial deposits in the beds and on the banks of rivers.

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| <p>6. Chella chólam.—From Cuddapah.</p> <p>7. Argudia jowári.—From Hyderabad.</p> <p>8. Bhendya jowári.—A red variety from the Raichori Do-áb.</p> <p>9. Lamdejowári.—A red variety from the Raichore Do-áb.</p> <p>10. Kávali jowári.—A white variety from the Do-áb.</p> | <p>11. Mundarasólam.—From Pondicherry.</p> <p>12. Muttre sólám.—From do.</p> <p>13. Dúdh mogra.—White and pink jowári, with flat grains, from Hyderabad.</p> <p>14. Kákai chólám (lit. Crow cholam).—A black variety from Pudukotta, in Trichinopoly.</p> |
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In the Exhibition of 1859 some additional kinds were found, viz.:—

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|---|---|
| <p><i>From Cuddapah.</i></p> <p>15. Bhat wáni.</p> <p>16. Gaji wáni.</p> <p>17. Chandal wáni.</p> <p>18. Jaipúr.</p> <p>19. Wunga.</p> <p><i>From Mysore.</i></p> <p>20. Kolada jola.</p> <p><i>From the Raichore Do-áb.</i></p> <p>21. Mellaji jola.</p> <p>22. Bilapla.</p> | <p>23. Ken jola.</p> <p>24. Niru jola.</p> <p><i>From Trichinopoly.</i></p> <p>25. Maskata chólám, probably an Arabian variety.</p> <p><i>From Tinnevely.</i></p> <p>26. Kuruvi chólám.</p> <p><i>From Cuddapah.</i></p> <p>27. Kal nakki jowári.</p> <p>28. Itrinjola.</p> |
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M. Perottet has observed that the grains or corns of the *Imphi* and Chinese varieties are larger and finer than those of the common *cholam*, and regrets that the ryots do not care to sow them.

This remark suggests the importance of using greater care in the selection of the indigenous seed. From the above remarks on the grain of Rajahmundry, it will be seen how striking are the diversities in the quality of this grain.

There is little doubt that if pains were taken to secure the selection of the best description of seed only, and if such seed was supplied by one province to another, the indigenous grain would become equal in every respect to the African and Chinese varieties. For this purpose, the best and largest corns should be selected, by passing the seed through sieves like those used by the pearl merchants, which retain the larger and permit the smaller grains to pass through. In the

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experiments made at Rajahmundry, I found that 100 selected corns weighed 52 grains; another set, 53·3; while similar parcels, taken at random, weighed 42·5, 43·2, and 44 grains.

In conclusion, I recommended that the committees of the local exhibitions should be authorised to offer rewards for the best samples of seed-grain."

The attempt to introduce the cultivation of *Impbi* was not confined to Madras. In the last number of the *Journal* of the Royal Asiatic Society, a short account is given by Mr N. A. Dalzell, Conservator of Forests at Bombay, of the experiments made by officers in charge of districts under that presidency for the same purpose.

From this it would appear that they were attended with success, and that but partially, in three districts only.

In Belgaum the *Impbi* attained a height of 11 feet, with abundance of sweet juice; in Sattara it grew to 8 feet, and forty of the stalks yielded a pound of molasses; while in Kándés they reached a height of 9 feet with a diameter of 3 inches, but were found to contain but little saccharine matter. The *karbi* or straw, however, was found to yield excellent forage for cattle; and in the neighbouring district of Poona, where the trial was even less successful, the collector considered the *karbi* to be worth five times the same quantity of that derived from common *jowári*.

Mr Dalzell recommends that the experiment should be continued, on account of the eminent success it has obtained in Scinde, where it appears to have answered entirely.

2. *Penicillaria spicata*, Willd. ; *Holcus spicatus*, L.

Of this grain there appear to be four specimens. It is known under the following vernacular names:—

Spiked Millet.

Kambu— <i>Tamil</i> .	Bájra,	} <i>Hindi</i> .
Gante, gantelu— <i>Telugu</i> .	Sazgaran,	
Sajji, sajjalu— <i>Telugu</i> .		

There appear to be fewer varieties of this than of most Indian grains. Roxburgh enumerates four kinds as cultivated by the Telugu ryots:—

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| 1. Pitta ganti. | 3. Pulla-boda-ganti. |
| 2. Munda-boda-ganti. | 4. Yeora-ganti. |

And among those sent to the Madras Exhibition from the south were—

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|-------------------|------------------|
| 1. Kuruvai-kamba. | 3. Perung-kamba. |
| 2. Kátadi-kamba. | 4. Puttu-kamba. |

Of all of which there are specimens on the table.

3. *Eleusine Coracana*, Gaertn. ; *E. stricta*, Roxb. ;

Cynosurus Coracana, L.

Lála,	} Sanscrit.	Tami, Tamidalu,	} Telugu.
Srinika,		Chollu,	
Kévuru,	} Tamil.	Rági,	} Hindi.
Keppai,		Náchani,	
Kelvaragu,			

It may fairly be questioned whether Roxburgh was justified in separating his species from the old *Coracana*, from which it differs only in having the spikes straight instead of curved, and being somewhat larger. The natives make no distinction that I am aware of, and they are very ready to see differences.

Rági is perhaps the most productive of all the Indian cereals. Roxburgh mentions the wonderful increase derived from two single seeds which came up accidentally in his garden, and yielded 81,000 seeds or corns.

It is the staple grain of the Mysore country, where it is produced in larger quantity than the demand, and is stored in pits in which it keeps sound for years.

During the great famine of 1813 these stores were opened, and tended greatly to relieve the distress. The Canarese still call this the Rági Bar or Rági Famine, to distinguish it from the great famine of 1802–3, which they call the Dógi Bar or skull famine, from the bones of the victims which lay unburied whitening the roads and fields.

4. *Setaria italica*, Beauv. ; *Panicum italicum*, L.

Is represented by six specimens. Its names are :—

Kangu, Kanguni,	} Sanscrit.	Korra, Korralu—	Telugu.
Priyanguh,		Kangui,	} Hindi.
Tenai—Tamil.		Rála.	

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It is a small, round, shining grain, generally of straw colour, but sometimes passing into black or red. The specimens on the table are :—

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|-------------------|-----------------|
| 1. Aruppu-tenai. | 4. Sen-tenai. |
| 2. Seguppu-tenai. | 5. Sadai-tenai. |
| 3. Sembu-tenai. | 6. Tenai. |

5. *Panicum miliaceum*, Linn.

Of this the collection contains seven samples. The ryots distinguish two varieties, the one a small shining seed resembling that of *Setaria italica*, varying in colour from grey to black, and known as *sámai*; the other of the larger size is called *kádai-kanni*, or quail's eye, and is marked with fine lines. Its names are :—

Varaka— <i>Sanscrit</i> .	Boragu, boragalu— <i>Telugu</i> .
Sámai, . . . } <i>Tamil</i> .	Sáwa, sáma, } <i>Hindi</i> .
Kádai-kanni, }	Chéna, china, }
Varaga, varagalu— <i>Telugu</i> .	

There are no specimens of *Panicum frumentaceum*, Roxb. ; *Oplismenus frumentaceus*, Kth. It greatly resembles the last, and is generally distinguished by the same names :—

Sámai— <i>Tamil</i> .	Sáwa— <i>Hindi</i> .
Boragu— <i>Telugu</i> .	

6. *Paspalum scrobiculatum*, Linn.

Six specimens occur of this grain, which is a small round semi-circular seed, of a brownish or chestnut colour, generally covered with a thin film. Its vernacular names are,—

Kodrava, . . } <i>Sanscrit</i> .	'Arike, 'Arikalu, } <i>Telugu</i> .
Koradúsha, }	'Allu, . . . }
Varagu— <i>Tamil</i> .	Kódru, Kóra— <i>Hindi</i> .

The florikin, or little Indian bustard, is often found in fields of this grain, and hence is called in Tamil *varagu kóli*. It is an inferior grain, only used by the poorest classes, and not reckoned very wholesome.

7. *Cynosurus ægyptius*, L.; *Dactyloctenium ægyptiacum*, Willd.

Of this two specimens occur. It is a small seed, intermediate in size between that of *Penicillaria* and *Setaria*, covered in part with a bearded husk, through which the shining seed is seen. It derives some of its native names from its resemblance to grass seeds.

Pil-arisi, or grass-rice,	} Tamil.	Disakalu, ...	} Telugu.
Kudarai-velai, or horse-		Udalu, ...	
tail, ...		Safayid sâwa, or white millet—	
Erangu, ...		Hindi.	

The botanical name is given on the authority of Dr Rottler, but the *Dactyloctenium* is not stated to be cultivated by Roxburgh or Voigt. It may therefore be only a variety of *Panicum*, of which several kinds are cultivated by the Hill tribes.

8. The small grain, of which two specimens, one black, the other white, are found under the names of *ray-jira*, *kât-aravi-soppu*, has not been recognised. It was supposed to be a kind of *Amaranthus*, but is more probably a minute species of *Panicum* or *Eleusine*.

9. *Triticum vulgare*, Vill.

Two specimens of wheat were exhibited, one by General Cullen from seed sown at Ashamber in Travancore, 3000 feet above the level of the sea, where the average fall of rain is 95 inches. The other is from Bengal. It is cultivated, although to no great extent, in the Madras Presidency, on the black cotton soil of the table-land in Mysore and the Ceded districts.

10. *Zea Mays*, Linn.

This grain, though not cultivated as a field crop, is found in almost all native gardens, and in the back yards of the ryots, who toast the heads when nearly ripe, and eat the grain. They also toast the heads of the common *Sorghum* in the same way just before they become fully ripe. Eaten with butter,

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pepper, and salt, it makes a very savoury dish. Four specimens occur in the collection. The name is *makka-jonna*, *makka-chólani*, &c.

11. *Bambusa arundinacea*, Willd.

No specimen of the seed of the bamboo occurs in the series on the table, but several specimens were sent to the Madras Exhibition of 1857, among the "articles used for food." Although not generally eaten, it is used by some of the wild tribes inhabiting the forests as an ordinary item of diet; and during seasons of famine, which occur so often in India, numbers of the agricultural classes drive their cattle into the forests which clothe the mountainous tracts, in search of water and herbage, and they themselves subsist on the seed of the bamboo. It is, however, hard and unpalatable.

III. PULSES.

Of the agricultural products employed as food belonging to the *Leguminosæ*, the collection contains twenty-four specimens, viz. :—

Phaseolus vulgaris,	5	specs.	Lablab vulgaris,	3	specs.
Phaseolus Mungo,	2	"	Canavalia gladiata,	1	"
Phaseolus radiatus,	2	"	Pisum sativum,	2	"
Dolichos biflorus,	1	"	Kurnool beans,	2	"
Cajanus indicus,	3	"	Without labels,	2	"
Cicer arietinum,	1	"			

1. *Phaseolus vulgaris*, L. (French bean. Single bean of native gardeners.)

Four specimens were contributed to the Exhibition from Pondicherry, and one from the superintendent of the Botanical Garden at Utakamand. This species is not an article of field produce, nor of general use among the natives of India, its culture being confined to gardens near European settlements. It hardly, therefore, deserves a place in this memorandum, but it is supposed to be indigenous to India, though now spread over the whole world.

2. *Phaseolus Mungo*, L.; var. *a. chlorospermus*. (Green gram.)

Mudga— <i>Sanscrit.</i>	Pacha-pesaru, pacha-pesalu—
Pacha-payar, } <i>Tamil.</i>	<i>Telugu.</i>
Siru-payaru, }	Harya-múng— <i>Hindi.</i>

Var. *β. melanospermus*; *Phaseolus Maz*, Roxb. (Black gram.)

Mudga-parni— <i>Sanscrit.</i>	Nalla-pesaru, nalla-pesalu—
Karuppu-payaru— <i>Tamil.</i>	<i>Telugu.</i>
	Kála múng— <i>Hindi.</i>

This is one of the most useful and largely cultivated of the Indian pulses. It is sometimes sown in alternate drills or bands, with the great millet (*Sorghum*), or spiked millet (*Holcus*), and in rice cultivation a crop is very generally taken off the same land when it has become dry. It is sown in the cold weather and is reaped in the hot season, after a period of from seventy-five to ninety days. The grain is largely used by the cultivating classes as an article of diet, mixed with rice, and the straw is left on the ground, which it serves to manure. So large a proportion of the pulse crops does it form, that these are collectively termed *payaru*, hence the word is synonymous with our "pulse." The black variety is less esteemed than the green, and is sown somewhat earlier, being supposed to require more moisture.

The flour of the green variety is an excellent substitute for soap, leaving the skin soft and smooth, and is an invariable concomitant of the Hindu bath.

3. *Phaseolus radiatus*, L. and Roxb.; *Phaseolus Roxburghii*, W. and Arn.

Másha, } <i>Sanscrit.</i>	Uddalu— <i>Telugu.</i>
Vrishya, }	Másh, } <i>Hindi.</i>
Ulandu— <i>Tamil.</i>	Urud,* }
Minumu, minumulu— <i>Telugu.</i>	

This is, perhaps, the most esteemed of all the pulses, though not the most extensively grown. It bears a higher price, and is more in request among the better classes, entering largely into many of the more delicate dishes and cakes, such as the

* *Urud* is sometimes applied to the black grain *Phaseolus Maz*, but more correctly to this species.

paparam or relish cakes, and those baked for religious ceremonies. Mixed with grain, it is considered to be strengthening for horses. The straw makes good fodder for cattle.

The seeds, as in the last, are both black and green, and hence it has a variety of names, as *máshparnè* in Sanscrit, and *káru-minumu*, in Telugu, for the black kind.

An average seed is the origin of one of the most common weights in use by Hindu goldsmiths. The unit is the *rattí* or seed of *Abrus precatorius*, from five to ten of which make a *másha*, or about seventeen grains troy.

It may be proper here to notice *Phaseolus lunatus*, L., the Lima bean, which is much cultivated in gardens under the names of Duffin bean and double bean. The beans are quite as good as, and supply the place of, those of *Vicia Faba*, the common bean.

4. *Dolichos uniflorus*, Lam.; *D. biflorus*, Roxb. (Horse gram.)

Kulatthá, kulatthiká, } Sanscrit.	Ulavu—Telugu.
Balukulá, .	Kulthi—Hindi.
Kollu—Tamil.	

This species is much cultivated in South India, and affords the principal food of horses and cattle. For this purpose the seeds are well boiled, and given as soon as cool enough to be eaten. The liquor that remains is used by the lower class of servants in their own food. It occurs of all colours,—white, brown, and black.

Although no specimens are found in the collection, another species of *Dolichos* deserves mention here—

Dolichos sinensis, L.; *D. Catjang*, Roxb.; *D. tranquebaricus*, Jacq.

Rájamásha, } Sanscrit.	Alasanda, .	} Telugu.
Sumásha, .	Bobbara, bobbaralu, .	
Alasandra, .	Yenikóte, .	
Kárámani, } Tamil.	Danta-pesalu, .	} Lobiya—Hindi and Persian.
Sadai-payaru, }		

There are several varieties of this pulse,—white, red, dun, green, black, and varying also greatly in size, but distinguished by their form, which differs from all the other kinds in the beans being truncated at either end.

The flour is chiefly used in combination with other grains for making cakes, which are used by all classes.

5. *Cajanus indicus*, Spreng. ; *Cytisus Cajan*, L. ; *C. bicolor*, DC.
(Pigeon-pea.)

'Adhaki, . }	} Sanscrit.	Dál, the husked pulse or split
Varna, varní, }		peas—Hindi.
Tuvarai—Tamil.		Shákhúl—Persian.
Kandu, kandulu—Telugu.		In Bengal it is called <i>arar</i> .
Túr, the seed—Hindi.		

Of this there are several varieties ; a small kind, which ripens in half the time of the larger sort, is distinguished as the small *túr*. Two or three varieties are also cultivated in the hills of the North Circars, under the name of *Konda-kandalu*, *bangara* or golden *kandalu*, remarkable for their beautiful orange and red-spotted flowers.

The pulse, when split, is in great and general esteem, and forms the most generally used article of diet among all classes. It is chiefly eaten mixed with rice, a mess known as *khichri*—vulgó *kedjari*. Roxburgh assigns to it a comparative value in native estimation, after *Phaseolus radiatus*, to which he gives the first place, and *Cicer arietinum*, or chick-pea, which he reckons the second. But as far as the general and daily use of the several kinds may be taken as an indication of taste, the *Cajanus*, or pigeon-pea, must be considered as number one.

The best *túr* is sown in alternate drills with *Sorghum vulgare*, which ripens first and is cut while the *Cajanus* is quite small. It then remains for two or three months longer, and attains a large size, and is reaped at the very end of the harvest. The stalks are strong and woody, and are used for fuel. They are especially adapted for making the charcoal required in the manufacture of gunpowder.

6. *Cicer arietinum*, L. (Chick-pea. Bengal gram in the South.)

Chanaka, sanakha, }	} Sanscrit.	Bút, . . }	} Hindi.
Harimanthaka. }		Harbara, . }	
Kadalai—Tamil.		Nakhuda—Persian.	
Senaga, senegalu—Telugu.		Hims—Arabic.	
Chaná, channá—Hindi.			

A variety apparently of this pulse was sent from the Hyderabad territory to the Madras Exhibition of 1857, by Captain Taylor, under the name of *lath*.

The chick-pea is extensively cultivated, both as an article of diet among all classes, and as food for horses and cattle, in every part of India, except Madras, where its place is supplied by the *Dolichos uniflorus*. It is a *rabia* or after-crop, and ripens during the cold weather. At this time the dew with which it is covered is very acid, and is collected for vinegar by means of cotton cloths, spread over the field at night, and wrung out in the morning.

7. *Lablab vulgaris*, Savi. ; *Dolichos Lablab*, L. ; *D. tetraspermus*, Willd.

'Simbi, 'simbini,	} Sanscrit.	Anapa, ...	} Telugu.
Nispáva, . . .		Anumu, anumulu,	
Avarai,* . . .	} Tamil.	Chóta sim, . . .	} Hindi.
Mochakottai,		Balar, ...	

Of this there are numerous varieties, and it is found both wild and cultivated. I am disposed to class the next species, or *L. cultratus*, also as a mere variety of this, the typical form. The difference consists in little more than the degree of curvature of the legume, and of the base of the style forming its point, and in the longitudinal or transverse position of the seeds. Roxburgh has particularised seven varieties of the former and six of the latter, dependent on size, shape, and colour only.

Balar is cultivated to some extent in the fields as a *rabia* or cold weather crop; and it is used as food for cattle, and also enters into the diet of the poorer classes.

Lablab cultratus, DC.

Avarai, . . .	} Tamil.	Chikkuda—Telugu.
Válavarai,†		Chóta sim—Hindi.

Several kinds of this variety are cultivated by the natives

* *Avarai* is also a general name of pulse; another generic term is *Tattai-payaru*.

† Literally, Tailed Lablab, from the straight or slightly subulate point of the legume.

in their gardens, and very generally by the poorer classes, climbing over the roofs of their huts, and supported on trellises in front of them. The different sorts are distinguished by the colours of the flowers, which vary from white to red and purple, and by the size and shape of the pods, which exhibit every degree of curvature, from straight to semicircular, one kind being designated *bagh-nak*, or tiger-claw, from its greatly rounded form. The same diversity is observed in the colour of the seeds, which pass from white to yellow, and brown, purple, and black.

Hence the numerous synonyms which it has been found necessary to refer to the normal species, as *leucocarpus*, *microcarpus*, *spicatus*, *albus*, *purpureus*, *cuspidatus*, *cultratus*, *ensiformis*, all of which have been described by authors as distinct species of *Dolichos*, and all of which may fairly be reduced to *Lablab vulgaris*.

8. *Canavalia gladiata*, DC.

Simbi (common)—Sanskrit.	Tamma-kaya (cult.)	} Telugu.
Kóli-avarai* (culti- vated) . . . }	Adavi shimbi (wild)	
Tambattanga (wild) }	Bara sim (common)	} Hindi.
	Kharsambal, . . . }	

Canavalia gladiata, which is only found in a cultivated state, is probably the domesticated form of *C. virosa*. I have therefore included the native names of both kinds in the above list of synonyms. The term 'simbi or shimbi in Sanscrit, like *avarai* in Tamil, and *sém* in Hindi, has a generic signification, and is applied to beans or legumes as a class. *Lablab vulgaris* and *Canavalia virosa* grow wild in almost every hedge, and to a superficial observer have a strong family resemblance, differing only in size. Hence the same native

* *Kóli-avarai* signifies literally fowl or poultry-bean; *adavi-simbi*, wild bean; *tambattam-kai*, tom-tom or drum-bean; but Rottler has not this application of the word to a vegetable in his Dictionary, although the name is in universal use; *bara sim* is big bean. *Khar-sambal* does not occur in the Hindi Dictionary, but is given in Ainslie's "Materia Medica." The Arabic word *bagla* or *bakila* is also commonly used as a general name for beans; *sadai* or *chadai-payaru* is a Tamil name for large kinds of beans, and is given both to *Canavalia gladiata* and to *Dolichos sinensis*; *payattangai* is another Tamil generic term for pulse, being simply *payaru*-pods.

22 Mr Walter Elliot on the *Farinaceous Grains* and the

names are applied indifferently to both, with the qualifying terms, "greater," or "less," or "wild." Another species of *Canavalia*, *C. obtusifolia*, grows wild on the sands of the sea-shore, and affords excellent pasture for sheep.

9. *Pisum sativum*, L.

Several specimens of the common pea were sent to the Exhibition of 1857, among which were a few prettily mottled with olive-green, which may perhaps have been varieties of *Cicer*. They were exhibited under the names of—

Pattāni, . . .	} <i>Tamil</i> .	Gundu-sanigalu— <i>Telugu</i> .
Vidutti-kottai,		Batāna— <i>Hindi</i> .
Bodi-sanigalu— <i>Telugu</i> .		

Ainslie states in his *Mat. Med.*, that the pea is indigenous to the Mahratta country, but this appears to be a mistake. Several kinds are cultivated in Bengal under the names of sugar-pea, grey-pea, Patna or field pea, by the natives called *matār*, *dhurwa*, *kiraw*, &c.

The Karnool beans were not identified. They were flat, and prettily striped with white and black.

Besides the above, which refer to the specimens on the table, there are some other descriptions of *Leguminosæ* much cultivated in India, as—

Ervum Lens, L., or *Masūr*; *Adas*, Arabic.—In Bengal only.

<i>Cyamopsis psoralioides</i> , DC.,	{ Kottavarai,	} <i>Tamil</i> .
	{ Síni avarai,	
	{ Gúr chikkudu—	<i>Telugu</i> .
	{ Matki—	<i>Hindi</i> .

Lathyrus sativus, L.—Kasúr, kisári, lang.—Cultivated in Bengal, not in the south.

Vicia sativa, L. (the Tare)—Ankri, *Hindi*.—Cultivated only in Upper India.

Mucuna utilis, Wall.; *M. nivea*, W. and A.; *M. capitata*, Buch., are all cultivated in the gardens of the natives; and I have even met with *M. capitata* among the hill race in the mountains to the west of Vizianagaram. The vernacular names are,—

Púnai-avarai— <i>Tamil</i>.	|	Khamach— <i>Hindi</i> .
Surutu, suritkáya— <i>Telugu</i>.	|	

Psophocarpus tetragonolobus, DC., the Goa bean, is cultivated in gardens for the table, but not to any great extent. In Tamil it is called Goa bean; in Hindi, *chandári* and *chár-patti*. *Arachis hypogæa*, L., is grown in the fields for the sake of the oil expressed from its seeds:—

Vér-kadalai, } <i>Tamil</i>.	|	Mung-phali, } <i>Hindi</i> .
Mannili-kottai, }	|	Bhui-mung, }
Néla sanagula— <i>Telugu</i>.	|	

and *Trigonella Fœnumgræcum*, L., is grown extensively in gardens for its seeds and leaves, which are in universal use as a tonic and carminative ingredient of curries,—

Mathi— <i>Sanscrit</i>.	|	Methi— <i>Hindi</i> .
Vendaiyam— <i>Tamil</i>.	|	Halbah— <i>Arabic</i> .
Menti, mentalu— <i>Telugu</i>.	|	Shamlít— <i>Persian</i> .

The temperature of the tropics, so unfavourable to the preservation of animal substances, and the habits of the people, derived probably, in the first instance, from this very fact, but now inculcated by their religion, which forbids the use of animal food, explain the importance of the preceding list of cereals and pulses, forming the chief means of subsistence of upwards of 200,000,000 of people. To meet so vast a demand the bounty of Providence has not only bestowed the extensive list of products already enumerated, but has also added a vast supply of gourds, pumpkins, and other cucurbitaceous plants, and of numerous stimulating and carminative spices, for the preparation of condiments, to correct and flavour a diet so extremely vegetable. These, with the coco-nut, plantain (*Musa*), sugar, certain vegetable greens, and the produce of the dairy in the shape of milk, butter, ghee, and cheese, constitute the exclusive aliment of the Brahmins and others of the higher classes, and enter largely into that of the inferior castes, who also indulge in the occasional use of fowls, eggs, mutton, &c.

Of farinaceous vegetables the supply is small. They have nothing to correspond in importance with the potato, on which the poorer classes depend so largely in Europe. Several kinds of yam* (*Dioscorea*), of arum,† and the sweet potato‡ (*Convolvulus Batatas*), come under this head; but they are not consumed to any great extent, and are certainly not in daily general use.

In addition to the tropical cereals, several of the best European grains are also grown in all parts of India, where from greater elevation, or more northern latitude, they can be raised with success. Wheat is grown on the table-lands of the Deccan, and throughout the whole of Northern India, and forms a principal constituent in the diet of the better classes. Barley and oats are also cultivated in the north.

A valuable report on the articles of food exhibited at Madras, in 1857, was drawn up by Dr J. E. Mayer, Professor of Chemistry in the University of that place, and is included in the volume of Jury Reports, published the following year.

Having made a careful analysis of the four principal grains, viz.,

Rági— <i>Eleusine Coracana</i> ;	Bájra— <i>Penicillaria spicata</i> ;
Chólam— <i>Sorghum vulgare</i> ;	Rice— <i>Oryza sativa</i> ,

he obtained the following results:—

	Nitrogenous Matter.	Non-nitrogenous Matter.	Inorganic Matter.
Rági contains	18·12	80·25	1·03
Chólam „	15·53	83·67	1·26
Kamba „	13·92	83·27	·73
Rice „	9·08	89·08	·47

Comparing the albuminous or nourishing proportions with those of the European cereals, the following is the result:—

* Kilangu, valli-kulangu, *Tamil*; Pendalam, *Telugu*; Pandálú, *Hindí*.

† *Colocasia*, *Amorphophallus*, &c.—Sémbu, séppang-kilangu, *Tamil*; Cháma, chára, kandu, *Telugu*; Kanda, kachu, kacham, kachálu, *Hindí*.

‡ Sakara-valle-gaddi, *Tamil*; Chila-gadda, *Telugu*; Genusu-gadda, *Telugu*; Ratnálu, or Shakarálu, *Hindí*.

	Nitrogenous Matter, according to M. Boussingault's Analysis.	According to Mr Horsford's Analysis.
Wheat, . . .	14.45	17.24
Oats, . . .	13.93	15.24
Barley, . . .	„	14.72
Rye, . . .	10.07	11.92
Phaseolus vulgaris, . . .	„	28.64
Pisum sativum, . . .	„	28.02
Ervum lens, . . .	„	30.46

Mr Mayer did not analyse the pulses, but the preceding table shows how large a proportion of nutritive matter they afford in comparison with the cereals. And this affords a remarkable illustration of the coincidence between the results obtained by scientific inquiry and those derived from practical experience. For the native Indian, wholly ignorant of chemistry, has learned to correct the poverty of his rice diet by the addition of pulse, to prepare his favourite mess of *khichrī*, which thus yields an average supply* of nutritive aliment equal to that of the best and most wholesome cereals.

On a Recent Landslip. By Rev. JOHN DUNS, F.R.S.E.,
Torphichen.†

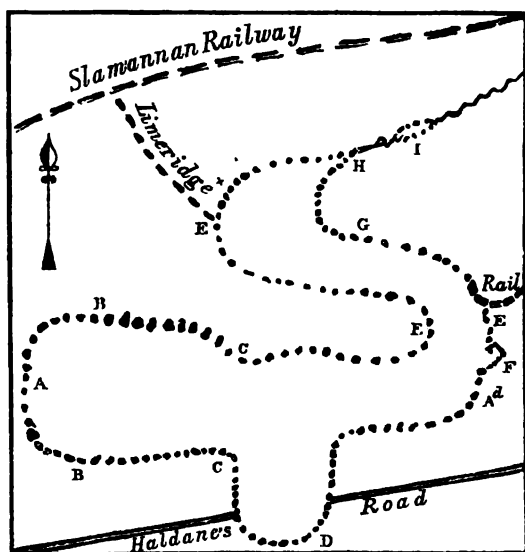
About seven A.M., of Monday, 12th August 1861, when a young man reached the south-east end of the Auchingray Moss, Lanarkshire, with the view of crossing to the other side, he heard, as if all around, a noise like that of the sea. Looking up the moss to the west, he was surprised and alarmed to notice, as he said, "the whole bog sinking and rising in a wavy-way for some minutes, and then breaking up with a loud crash." I visited the locality a few days later, when the moss was still in motion, and made the notes which I now beg to lay before the Society. The observations have some bearing on several not uninteresting phenomena in the formation of modern strata.

In pointing out the site of the landslip, one or two general

* Rice, 9.08 + pulse, 28.02 = 37.10 ÷ 2 = 18.55, the nitrogenous proportion of *khichrī*.

† Read to the Royal Society of Edinburgh, 17th March 1862.

remarks may be made on the prominent physical features of the district. A broad, irregular, and much broken mass of trap stretches in a south-west direction from Linlithgow to Airdrie. The lowest parts of this are generally in the centre. On both edges it shoots abruptly as dykes into the adjacent stratified rocks, and sometimes rises to a considerable height. The central depressions have often no other covering than stiff white or blue clays and peat. The clays, in these hollows, vary in depth from a few inches to nearly 20 feet. The peat ranges from 1 to 16 feet deep. Not far from Airdrie this trap sends one irregular fork to the north-west till it reaches Kilsyth, and another south-west to Glasgow. At the point where the trap ridge divides, and where the parish of New Monkland, Lanarkshire, meets that of Slamannan, Stirlingshire, a broad and deep depression occurs. In this lies the Auchingray Moss, the scene of the landslip.



The accompanying rough plan of the ground lying between the Slamannan Railway on the north, and Haldane's Moss Road on the south, will help to illustrate the following remarks. The area occupied by the landslip is enclosed by dotted lines.

It might be concluded, from the present aspect of the ground, that the slip had been confined, in its whole length, by the heath-clad ridges represented by A and B B, which bound it on three sides. But the space where these elevations now appear was very little, if at all, above the level of the surface set in motion. The great depression now seen is the result of the immense quantity of soil carried away while the force lasted. On sounding some of the water-filled gaps at the centre of the broadest part, B B, I found many of them 6 and 8 feet deep, and one 16 feet deep. This fact explains whence came the vast amount of peat soil, sent not only into the course of the stream below, but even into that of the Avon, to be cast on its banks as far down as Linlithgow Bridge, thirteen miles distant.

The effects of the landslip are first seen at A. Here all the masses have fallen forward to the east. At the widest part B B, the soil on the south side has fallen to the north, and that on the north has given way to the south. The pressure on three sides has thus been to the centre, where the depth is greatest. This seems to indicate that the force had first become active at that point, and also to suggest the explanation of the movement.

About forty years ago the central part was known in the district as the "Blind Loch,"—water, namely, covered with the reeds (*Typhaceæ*), rushes (*Juncaceæ*), horsetails (*Equisetaceæ*), bog-mosses (*Sphagnums*), and the like, which occur in such situations. This has for many years been so far solidified that people could cross it without inconvenience, though, as one remarked to me, "in winter it was always softish."

For some weeks before the occurrence of the landslip continuous rains had fallen. Sabbath, 11th August, was one of the wettest and most boisterous days of the season. The rain fell very heavily, and the wind blew strongly from the west. Great quantities of water appear to have reached the surface of the impervious underlying clay, and to have floated the lightest central part—the area proper of the "Blind Loch." Denser matter would then press in from the sides A and B B, and the slip, having carried away the breast-work on the east,

would naturally take the direction of least resistance, namely, the course of the stream which drains the moss.

The area set in motion may be roughly estimated as about 300 feet broad at B B, and 1320 in length from A on the west to A d on the east.

In its course it met with elevations at C C. The most formidable of these lies on the north side. This gave the flow a direction to the south, and led to the deposit of the tongue marked D, which is about 160 feet long by 100 feet broad, and is made up of masses of peat from 1 foot to 4 feet thick. Here damage was first done. The material spread over portion of a field on which a crop of oats was beginning to ripen, covered part of a highway formed at the expense of the late Robert Haldane, and known as Haldane's Moss Road, and wasted part of a field of turnips lying on the south of the road. At the point where the flow was forced to turn to the south, some very deep rents were to be seen, and proofs of great disturbance presented themselves everywhere. Irregular masses were lying in all positions. In some cases they have been turned upside down, and lie face to face with the sunken lumps which had previously formed the surface of the bog. Traces of the underlying blue clay, associated with branches and root stems of native birch (*Betula alba*), are to be seen on what is now the surface of the inverted masses. Among these I picked up fragments of land-shells, *Helicidæ*. Two species could be identified, *Zonites cellarius* and *Helix rotundata*,—the former by a fragment showing four whorls of the flattened spire, larger than a piece of any other British form of the genus would have been; the latter by its still distinctly marked radiated striæ. These shells must have been laid down on the clay contemporaneously with the birch branches and roots. No native birches are now to be met with near the moss. A long search for land shells produced only one *Helix* (*H. rotundata*), a species to be generally met with in the district, but not common on the sides of the Moss Road. The birches, no doubt, bear witness to a former landslip, of which we have now no other record. They must have been buried anterior to 1809, when Auchingray was purchased by the late Robert Haldane. His biographer says,

“On the estate, containing 2400 acres, there was but one solitary tree, a weather-battered ash, which stood beside the door in which the Principal of the University of Glasgow, Dr Macfarlan, was born.”

A peculiarity of many of the root stems may be pointed out. Instead of being rounded, like the branches, they have a central depression, or *sulcus*, on both sides; they are flat, recurvated, and run quickly to a point. Is this the form they assume when they strike into cracks in clay underlying soil in which they find their chief support? I have often noticed this peculiarity in the roots of one of our firs (*Pinus sylvestris*) in such situations. If this be so, these birches must have stood on a soil much nearer the bottom clay than any tree that might now be planted on the moss would do. In shape the stems curiously bear a strong resemblance to many fragments of *stigmaria*, met with among the debris of the neighbouring coal pits.

When the soil set in motion by the slip reached the extreme south of the tongue marked D, it again turned north, and, bending north by east, it met a plantation of Scotch firs, which stretches from the highway down to the stream which drains the moss. A few of the trees have been carried several yards forward, and now stand in an upright position, as if they had not been moved from their place. Some have been violently thrust top downwards into the underlying clay. Others have been placed horizontally on the edge of arrested lumps of peat. The flow at this point covered part of another corn-field. A little to the north of A *d* it filled a whinstone quarry 15 feet deep, F. At the narrow neck E E, the depth of the flow was more than 12 feet. Turning this neck, it met the Limeridge Railway—a mineral traffic branch of the Slamannan line—swept part of it away, covered a large portion of it, and did much damage to a third corn field lying north-east of the line.

An intelligent lad, who watched the landslip from its commencement, wrote: “*August 15th*.—The railway is now covered half-way down to the main line. The company are lifting the rails before it, as they would not get them again, there being such an awful body of it. My father and I came round that

way this morning about five o'clock. It was moving at the rate of a yard every two minutes." "*August 16th.*—The moss is now coming down Binniehill Burn like tar." "*August 17th.*—The moss is now down to Binniehill. The haugh below the office is covered with it as wide as Clyde at the Broomielaw Bridge. It is a black looking country here." The rate of progress was much slower near the centre of the slip. I stood on several of the huge masses as they moved along, but the motion was scarcely perceptible. A peculiar tremulous sensation was communicated by the movement, much like that felt by one standing on a railway platform when a train is slowly passing.

Turning from the Limeridge Railway, the flow filled a small natural basin, marked G G. Many of the lumps left here were of great size. One measured 7 feet by 4 feet, and was nearly 6 feet deep. At H, on the east of this basin, great quantities of flow were carried into Binniehill Burn. As the stream at this point is confined by steep banks, the floated peat must have been 6 feet deep, judging from the traces it left on both sides. At I it entered the haugh described above as being "as wide as Clyde at Broomielaw Bridge." The next place favourable for the flow spreading occurs in the haugh opposite Binniehill House, which stretches down in the direction of the Avon, on the east of Slamannan village. Here it covered the highway at two points, and left in many places about two feet of peat on the top of soil which had been under cultivation.

In preparing this paper several relative topics have been suggested, to which I may be permitted to allude very briefly:—1. The uncertainty associated with fluviatile deposits, both as regards age and manner of deposition. When the material set loose by this landslip reached the Avon, it was drifted at several points into hollows on both sides of the river, in which it left from 1 to 2 feet deep of peat soil. The river suddenly rose higher than usual during the rapid thaw of the snow which fell on Thursday the 6th current (March 1862), and, in some cases, covered the peat with 6 inches of sand and gravel; in others, it swept all traces of the landslip completely away. 2. Though the Auchingray landslip is not

to be compared, in its extent and in the injury done, to the great Solway landslip of 1771, yet in many respects they bear a strong resemblance to each other. In the beginning of last autumn Mr James Cunningham and myself visited the scene of the Solway slip, and were able to trace it over the whole area it had influenced, as we afterwards found on consulting the plan given in "Hutchinson's History of Cumberland" (1794). The remains of the flow of the Solway slip is now in many parts covered with nearly a foot of the red soil, formed from the local Permian rocks, which has been pushed in over it from adjacent fields, and deepened by agricultural operations. This was early realised. Hutchinson (as above) writes, "Every inch of the ground, thus almost miraculously destroyed, has been and is totally recovered; and is at this moment waving with richest harvests. All the plain is now in good order and tilth, as if no such astonishing event had happened." The same process is already at work where the Auchingray slip has left its debris. At the centre of influence of the Solway slip deep sections have been made in the peat, and distinctly marked bands of a light colour may here and there be noticed,—traces, no doubt, of inverted masses like those described above. 3. At the place, in the course of the Avon, where the waters were most influenced by the flow, many of the largest trouts perished. Soon after the Solway slip occurred, Gilpin wrote an account of it, in which he says, "The overplus found its way into the Esk, where its quantity was such as to annoy the fish; no salmon during that season ventured into the river." 4. On the day before the Auchingray slip happened, the "Black Loch," which lies in a basin slightly elevated above the moss about a quarter of a mile south by east, was more than usually agitated, and rose higher than it had ever been observed to do. On the day on which the slip occurred, the "Elrigg Loch Moss," nearly three miles distant, moved *en masse* more than 3 feet forward in the direction of the Loch. 5. The county which the flow specially influenced has long been noted for its periodic changes of large areas of surface. Illustrations are given in Nimmo's "History of Stirlingshire" (1777) which deserve to be kept in mind. Many such notes occur in local histories which should

not be lost sight of. They not unfrequently correct the conclusions formed from recent surveys, and will always be found useful in the study of the surface geology of particular districts. One quotation may be made from Nimmo. "In the last century," he says, "a phenomenon appeared in this shire, proceeding from the same causes, and similar in many of its circumstances to that which took place a few years ago at Solway Moss. A part of a large moss, called Lethen Moss, lying between the parishes of Larbert and Airth, was suddenly removed out of its place by the water, which had been pent up in its cavities, forcing a passage to itself, and carrying along with it to a considerable distance so large a quantity of the flow as covered near an acre of ground. The scattered fragments that were thus pushed by the flood are still to be seen at the bridge of Pow House, at a great distance from the rest of the moss. The people in the neighbourhood mention the same observations as having been made by their forefathers which were made upon the eruption at Solway, as that the moss at that time sensibly subsided, so that objects before invisible to those that dwelt on opposite sides of it began to appear; particularly that the hill of Airth, which before was totally intercepted by the moss from the sight of those who lived upon the west, became immediately obvious to their view." 6. On visiting the district last month, I noticed that the part marked D on the plan has already begun to lose many of the characteristic marks of disturbance, and is fast assuming all the appearances of a regularly formed gradual deposit. Now, were mining or other operations to lead to the opening up of this sixty or seventy years hence, the surface geologist might find in the section material for generalisations of the most startling kind. A section made to the surface of the trap would reveal the following points,—blue clay, several feet of peat, a grey soil having embedded in it the straw and grains of the common oat, and, on the top of all, peat, say six feet thick. "Peat," the observer might affirm, "is deposited at the rate of one foot in thickness in 300 years. This layer shows all the evidences of gradual deposit through long centuries! Six feet in thickness, it tells the interesting tale of 1800 years. Our Caledonian forefathers must then have been much misrepre-

sented by the Romans. At the period of the Roman invasion the Celts could not have been rude savages. Proofs are before us which should satisfy the most sceptical. They were devoted to agriculture. Here are distinct traces of *Avena sativa*! That iron instrument embedded in the grey soil—a rude form, no doubt, of our highly polished curved harrow-tooth—bears witness to considerable progress in the useful arts!" Such reasoning is not uncommon, based on data *almost* as reliable as those furnished by the Auchingray landslip.

The Geology of Moffat, Dumfriesshire. By WILLIAM CARRUTHERS, Esq., F.L.S.*

Lithology.

I purpose in this paper describing the geological features of the district around Moffat, taking the village as my centre, and including all that lies within a radius of four or five miles. The district is situated in the centre of the immense Silurian tract of the south of Scotland; its predominant rocks consequently belong to the Silurian period. A red sandstone lying unconformable to them is the only other stratified rock. The superficial deposits are not numerous; they consist of boulder clay, gravel and sand, peat and shingle. A trap-dyke, which runs through the district a mile below Moffat in a south-east direction, is the only igneous rock with which I am acquainted.

Bibliography.

I shall confine this bibliographical notice to works bearing distinctly on the district around Moffat. Hugh Miller has given, in a paper read to this Society in 1852, an admirable history of the Silurian rocks of the south of Scotland.

In the Old Statistical Account of the parish (1792), the Rev. Alexander Brown, the immediate successor of Dr Walker, describes the soils, and alludes to some of the economical products of the parish.

In 1775 Annandale was searched for coal by Mr Burrel,

* Read before the Royal Physical Society, on 26th March 1862.

but the account of his survey remains in the possession of the county unpublished.

In 1800 the county gentlemen were anxious to obtain a geological description to accompany their excellent county map, and for this purpose applied to Robert Jameson, then a favourite student of Dr Walker's, to survey the county. He was on the eve of setting out for Germany, and consequently declined at that time to undertake what he afterwards in 1805, on a renewed application, performed. In the meantime, General Dirom prepared some sections of the county, from published data, which were engraved on the map; and the Messrs Busby, two coal-viewers from Northumberland, were engaged to survey the county. Their journal was published as a supplement to Dr Singer's "Agriculture of Dumfriesshire," 1812. It shows them to have been shrewd men, with quick eyes and sound judgments. They were not led astray by the dark shales to expect coal in the "primitive" rocks; they searched in them for minerals and slate. They found no certain indication of the former, but recommended a locality in the Frenchland Burn as a likely locality for the latter. They bored also for marl, but without success, at Calla Bank and Loch House.

Professor Jameson, in his "Mineralogical Account of Dumfriesshire," 1805, first referred the predominant rocks of the south of Scotland to their true position. Hutton, in his "Theory of the Earth," considered them as *primary* strata, but Jameson showed that they were members of Werner's Transition Series. He gives an accurate account of the mineralogical peculiarities of the rocks, but is entirely ignorant of the contained fossils. He examined the shales at Hartfell Spaw, but noticed only their mineralogical appearance, and failed to observe the graptolites which abound in them. An anonymous critic, evidently acquainted with the rocks of the district, says, in a review of Dr Jameson's work, in the Literary Journal for 1806, "We know that *vegetable petrifications* are very common in the greywacke slates of Dumfriesshire." The graptolites, which this unknown writer had evidently observed, remained unnoticed yet for many years. It seems scarcely possible that the keen eye of Dr Walker

could have failed to see them. He says, "During my long residence at Moffat I collected, in a number of short tours, all the remarkable minerals of Dumfriesshire." We cannot now ascertain to what extent the structure and peculiarities of the district had been determined by him, because of the unfortunate loss of all his papers. It was not till the year 1850 that Harkness, Sedgwick, Murchison, and others, again drew attention to the rocks of the district, and re-discovered the forgotten "vegetable petrifications." In the interval much had been done to determine the structure and position of the rocks of the south of Scotland, by Maclaren, Nicol, and Sedgwick. Professor Harkness, in his valuable and interesting papers published in the "*Geological Journal*," 1851, refers the rocks of the district to the Caradoc sandstone, from the characters of the graptolites. He describes in detail the anthracitic shales. An examination of their various localities led him to the conclusion that there was an anticlinal axis at Dryfe Water, that the strata north of this dipped northwards, and those south dipped southwards, and that the frequent recurrence of the graptolitic shales was produced by three faults—the various localities grouping themselves, as he supposed, into three series. Sir R. Murchison, while travelling from Dumfries to Moffat in the same year, supposed that the axis existed to the north of the former town, and published this opinion in his "*Siluria*," 1854, considering it identical with that of Harkness, and using one of that gentleman's diagrams to illustrate his views.

This is the generally received theory of the structure of the districts.

Silurian Rocks.

The Silurian rocks in this district are remarkably similar in their composition and structure. There are no alternations of limestones, sandstones, shales, &c., as in the newer formations, or even in the Silurians of some other districts. The rocks are almost entirely composed of water-worn quartz grains and clay. These materials have been deposited either as mud, or as sand of different degrees of fineness, or of a mixture of both, and have produced shales or sandstones

which are extremely indurated, from the long continued metamorphic action to which they have been subjected. The argillaceous sandstone or *greywacke rock* is the predominant rock. It is generally fine grained, and of a uniform greyish colour, breaking with an uneven and somewhat conchoidal fracture. The beds in which it occurs are generally of considerable thickness, though occasionally it is met with in thin layers, as at the Common Craig, where it has for long been quarried as a building stone. It forms a beautiful and very durable building material. A large portion of Moffat is built of it. The *shales* are generally light coloured, but in some places they are more or less blackened by anthracite, derived originally either from the animal bodies whose remains abound in these shales, or more probably from the sea-weeds that were their companions in the Silurian seas, and which, from their soft cellular structure, have left no definite traces behind them on the rocks. Iron pyrites, aggregated in small nodules, or scattered through the substance of the rock, is common in the shales. So also is alum; at Garple the shales are so highly aluminous, that a mineral water is obtained by dashing the water of the burn against the more friable layers. Hand specimens of the shale are frequently broken up in the cabinet by the contained alum forming into masses of beautiful acicular crystals and separating the original layers of the clay. The whole of the strata are singularly free from lime. The only calcareous rock that I am acquainted with is found in Garple Glen, but it contains such a small proportion of lime, joined to a large amount of mud, that it is of no economical value. Small veins of calcareous spar, as well as of quartz, occur frequently in the rocks. The indurated light-greyish or cream-coloured shales have been quarried for roofing slates at the head of Corrieferan Glen. They exfoliate in the planes of stratification, and have no true slaty cleavage. They are thick and heavy; and though very durable, the bad roads, and the working expenses of a quarry in such a locality, have caused them to be neglected.

The general directions of the strike of the Silurian strata is east and west; and the dip, when not vertical, is always at a very high angle—70° or more. Professor Nicol has noticed

in Peeblesshire what may be observed in this district also, that the direction of the dip is towards the interior of the mountain chains, being south on the north, and north on the south side. The few scattered records of the strike and dip of the Silurian strata of the south of Scotland seem to be insufficient to establish a satisfactory theory of their structure. This will follow only after the observing and recording on a good map a large series of observations throughout the country from St Abb's Head to Portpatrick, and from the Pentlands to the Solway. The theory of Professor Harkness, adopted by Sir Roderick Murchison, does not seem to meet the facts. Many of the additional localities for graptolitic shales, discovered within the last ten years, do not fit into his three faults. Nor does it seem possible that strata, vertical, or so highly inclined, could repeat themselves in a series of faults. Faults cannot *tell*, except on more or less horizontal strata. It is more in accordance with my own observations and those recorded by others, to believe that the position of the strata is owing to enormous flexures produced in a manner similar, but not so regularly, to what has been observed and ably expounded by the Professors Rogers as occurring in the Appalachian Mountains.

Permian Sandstone.

The red sandstone is a very friable rock, the quartz granules of which are held together by a ferruginous cement. Its structure is frequently very coarse, forming a sandstone conglomerate, containing numerous generally angular fragments of the Silurian rocks. At Newton it has a fine and uniform grain. A few years ago a large quantity was quarried at this place for building, but it was so friable that it could not be used. It occurs in the bottom of the valley of the Annan and some of its tributaries, in strata nearly horizontal, rising slightly towards the surrounding high ground. It may be traced at the base of Hartfell, extending from the Corehead Burn to within about a hundred yards from the Meikleholmside Bridge, where the greywacke rocks come down into the bed of the river, and make an evident break in the sandstone. It appears again further south on the roadside about three-

fourths of a mile beyond Moffat. Probably this section and the appearance of the same strata in the bed of the Well Burn, were the foundation for Professor Jameson's statement, that the Gallows Hill (he evidently by mistake writes Chapel Hill) was formed of this sandstone. The same deposit occurs on the west side of the Annan, opposite Moffat, in the Horse Linn, and in Langshaw Plantation. It is found also in the Frenchland Burn, at Beld Craig, Wamphray Water, Raehills Glen, &c.

This sandstone has hitherto yielded no traces of fossils in the district. It is evidently related to the red sandstone of the lower part of the valley, which contains the tracks of reptiles so beautifully figured by Sir William Jardine; and is thus most probably of Permian age. It has been deposited since the valley assumed its present conformation, though some changes have taken place since its deposition, as is evident from the inclined position the beds occupy in the Horse Linn, and in the localities where the junction is seen between them and the Silurian strata. Probably these last changes were contemporaneous with the intrusion of the trap-dyke, which we shall presently notice, and were the result of the causes which produced it.

The Permian sandstone was referred to the Carboniferous series by Professor Jameson, Dr Singer, and others. Hence arose the notion that coal existed in the district. Dr Singer, in his "Agriculture of Dumfriesshire," 1812, at considerable length and with great ability, examines the merits of the case, and concludes that as coal has been found under red sandstone, the Coal-measures may be hid by these strata in this district. He therefore recommended boring, and he regrets that an attempt made near Nethermills was stopped before anything satisfactory could be determined. The examination of the district, however, shows that the conclusion of Dr Singer, though correct theoretically, is really incorrect, for it is evident at the various junctions of the formations, as in the Newton, Hartfell, or Frenchland Burns, that the unconformable sandstone rests immediately on the upturned edges of the Silurian strata.

The occurrence of the black, coal-looking, anthracitic Silu-

rian shales in many localities, has led to the belief that coal existed in their neighbourhood, and has caused several abortive attempts to reach it to be made, in opposition to the published opinions of the Busbys, Jameson, and Singer. It is remarkable that landed proprietors in every Silurian region have been induced to spend their money in vain attempts at searching for coal, where these anthracitic shales occur, on the recommendation of empirics, and generally in opposition to the published or known testimony of scientific men.

The Trap Dyke.

The Trap Dyke has been quarried for some years at a point where it projects on the surface near the summit of the Lochhouse Hill. It supplies the bluish stone which has been extensively used in the recent buildings in Moffat. Its relation to the strata, through which it is intruded, can be best seen in the bed of the Evan, a little above Longbedholm Cottage. Its direction is N.W. by S.E. Beyond the point where it crosses the Evan, it may be traced in a N.W. direction until it crosses the line of the Caledonian Railway. In the opposite direction it has been quarried on Evan road side. It pushes out into considerable prominences in several places on the Coates Hill. It is also quarried, as has been said, on the Lochhouse Hill, and again in a plantation on the farm of Woodhead. Mr David Stewart has observed quarries in it in Dryfesdale and Eskdale. I believe it to be the same dyke that occurs again at Langholm.

It is a compact, fine-grained greenstone, distinctly crystalline in the centre, and becoming compact and amorphous at the edges. It is 32 feet wide at the quarry on the Evan road.

It is difficult to determine positively the age of this dyke from the strata in this district. If the position of the sandstone on the sides of the Coates Hill tells, as it seems to do, that this hill was elevated subsequently to the majority of the hills around, then this trap dyke must be either a contemporaneous or subsequent intrusion.

The Boulder Clay.

The boulder clay is a light-coloured clay, containing small

boulders, many of them having the rubbed and polished appearance peculiar to and common in this deposit. It covers the Gallows Hill. The only section of it that I have seen is in a gully in a narrow plantation running down from the Old Well road; but this is of no great depth. It is exposed in the Whins, where it is sometimes dug for use in the village. The shoulder of land between Moffat and Annan Waters, forming Aikrigg farm, seems to consist also of boulder clay. A few of the large boulders here lying on the surface are from the Trap Dyke, which passes through the fields in this locality, although it cannot be detected on the surface.

Gravel, here and there intermingled with sand, occupies the bottom of the valleys. At Granton, on the Dykefarm and in other localities, it exists in considerable masses. It presents no peculiarities requiring particular notice.

The sides of the hills are covered with angular shivers—fragments of the underlying rocks—mixed with soil.

Peat is abundant in the district. The flat summits of the mountains are covered with hill peat formed of, and now forming from, the mosses, lichens, heather, and rushes which cover the hills. It is a friable peat, wanting coherence, and is generally intersected by innumerable gashes (moss-hags), formed by the draining of the rain-water. The peat in the low grounds, as at Lochhouse, contains the trunks of trees of species similar to what still grow in the district,—fir, hazel, and birch.

Episcosmology. By HUGH DOHERTY, M.D., Dulwich.

In a Philosophical Journal we may deal with the speculative questions of natural science as well as with descriptive outlines; and the increasing difficulties of inductive method show that the time has arrived for dealing with principles as well as facts. We therefore beg leave to ask the following questions, and comment upon them, from a certain point of view.

Is there an Architect of nature, and a plan of order in organic structure and genetic evolution? Does Scripture con-

tain an outline of the plan of natural and spiritual evolution on our globe? Is man himself a microcosmic universe constructed on the same principles of order which reign in the macrocosmic universe?

Can inductive method answer any of these questions, or must we have recourse to a deductive method to put order in the multifarious cumulations of inductive observation and description! We believe there is an Architect; that He has a plan; and that this plan is openly revealed in human nature. From this hypothesis we form a conception of divine order in the realms of nature, and derive from it the principles of a deductive method to complete the labours of inductive science.

Principles of law and order cannot be discovered by induction, which is only capable of descriptive accuracy and congeneric grouping. The conception of a principle or model plan, from which organic method may divine the natural order of arrangement, is necessary to complete the cumulative labours of induction.

Without a teleological conception to give life and purpose to creation, the natural sciences, built up in fragments by inductive method, have no real meaning for the human mind, which looks upon their various results as a child might see a watch, and wonder what it was, or why it was constructed. Without a full and true conception of the principles of order, deductive method may be more delusive than inductive method; and we know that it has led the human mind astray more often in the progress of the ages; but still, the two are necessary to complete each other. One cannot do the work of real discovery without the other. Organic method is, in fact, a compound of the two; and those who think they follow the inductive method only in the natural sciences, delude themselves whenever they attempt to form a natural order of arrangement, and build up a system of classification based upon diversities of the nervous system, or some other portion of the internal structure of animals, or on diversities of the external form alone. Such conceptions, true or false, partial or complete, necessarily give rise to a deductive principle of method and arrangement. And even those who question all

such ideas of order, and confine themselves to the study of genetic evolution mainly, conceive a principle of "natural selection" to explain the "origin of species;" while their followers who still indulge the love of order and arrangement, multiply divisions of organic types as they proceed in multiplying observations and descriptions of the unexplored fields of nature. Two distinct "sub-kingdoms" have been lately recognised within the limits of the "zoophytes" of older naturalists,—*"Protozoa"* and *"Coelenterata;"* and this, with all due deference to those who deem it warranted by facts, we venture to think premature, for there has, confessedly, not yet been a sufficient study of the life-history of all the species, and the various modes of genetic evolution in the lower forms of the *Invertebrata*. The new and conscientious investigations which have led to this arrangement of "sub-kingdoms" cannot be too much lauded, but these distinctions are nevertheless, in our opinion, premature.

The genetic theory of "natural selection," varying with the conditions of external nature and modifying types of structure by gradual changes thus effected, makes no difference to the questions here proposed; for the Architect must have a plan or plans of structure, and a plan or plans of evolution, and the influence of external conditions in modifying structural evolution, as far as true in fact, must form a part of the great plan as a means to an end. The question still remains, What is the plan—what the end in view? To say we cannot know, is merely an evasive answer.

With regard to the distinction of "sub-kingdoms" in organic nature, we may observe that the great naturalists have taken the highest and the lowest degrees of evolution as the limits of distinct types of structure, in forming separate divisions. Cuvier defined four great plans of animal organism in zoology; Linnæus, two main types of vegetable structure in Botany. *Vertebrata*, *Articulata*, *Mollusca*, *Radiata*, *Phanerogamia*, and *Cryptogamia*; these are the most distinct organic forms in epicosmic nature. De Jussieu defined the lowest degrees of distinction in the vegetable world, when he described them as cotyledonous seeds, and acotyledonous. The study of fruits and seeds, and the various degrees of evolution from fruits

and seeds to the fullest development of every known species of vegetable, has been well conducted in most departments of botany. The study of ovology and genetic evolution has been more or less pursued in many species of animal organism, but not as yet enough, we think, to warrant us in forming a new "sub-kingdom" for the so-called "Protozoa." It would be just as natural to form a separate "sub-kingdom" for truffles and the lowest forms of cryptogamic vegetation.

All simple germs of organism—ova, spermatozoa, and the earliest stages of evolution in such germs—are more or less albuminous homogeneous bodies in a protozoic state; and when we compare the known varieties of genetic evolution in the lowest types of the Invertebrata with the various modes of propagation in the vegetable forms of structure, and the various stages of arrested development in each division, not to mention teratological deviations, we may hesitate before we form new typical sections such as those implied in the new sub-kingdoms of "Protozoa" and "Coelenterata."

In this conviction we confine ourselves at present to the old sub-kingdoms in zoology and botany; not that we object to numerous distinctions where they are natural and necessary, for we now propose a list of such divarications in the inorganic realms which may, perhaps, be deemed unnecessary by some competent authorities. The question is, however, one that must be dealt with from the deductive point of view as well as the inductive, before we can hope to arrive at a satisfactory solution. From our point of view, which may be wrong, and is no doubt imperfect, there are but twelve realms in epicosmic nature, half of which are inorganic and the rest organic. The number 12, in human nature, represents fulness and completeness, and not improbably in epicosmic nature also. The conception which postulates this view of things may require alteration, but it will first require proof of being incomplete or otherwise defective. In the epicosmic realms of our globe there are two primary distinctions to be made,—the Inorganic and Organic; and each of these contains several distinct realms of physical type and structure, which require separating from each other in the course of analytical investigation. In the first division there is an *Atmospheric* realm, an *Oceanic* realm, and a *Geo-*



spheric realm, a *Pluvial*, an *Exuvial*, and an *Elemental* realm; in the second division there are six organic realms. A dozen realms in the so-called "animal, vegetable, and mineral kingdoms."

These realms are neither continuous nor dichotomous in their connection; the atmosphere is not a continuation of the sea; the sea is not an "embranchment" of the land. Organic realms are equally distinct and parallel in distributive order. There is no common stem or type in which the different realms or "sub-kingdoms" meet, and therefore the word "embranchment" is inaccurate.

In the human body we have a complex universe of organs, and these are distributed in seven or twelve parallel systems. The teleological parallel between these systems of a complex microcosmic unity and the realms of an epicosmic universe is not, perhaps, self-evident, nor do we mean to dwell upon it here, further than to intimate that such a correlation does exist, as far as parallels of order and degrees are concerned. The skin, the muscles, the bones, and the central nerves, are more or less parallel and concentric in the body. The vascular, digestive, and generative systems are not concentric, but they are parallel in all their sub-divisions; and the same may be said of the five senses co-ordinate with the seven systems. A complete synopsis of the epicosmic realms, then, gives us twelve parallel divisions; thus,—

Inorganic Realms.

- A. ATMOSPHERIC REALM.
- a, b. Pluvial Realm.
- B. THALATTOSPHERIC REALM.
- b, c. EXUVIAL REALM.
- C. GEOSPHERIC REALM.
- D. ELEMENTAL REALM.

Organic Realms.

- ee. Cryptogamic Realm.
- E. PHANEROGAMIC REALM.
- ff. Radiata Realm.
- F. MOLLUSCA REALM.
- gg. Articulata Realm.
- G. VERTEBRATA REALM.

In a complete study of epicosmic unity we should have to consider the dynamic forces of heat, light, magnetism, electricity, cohesion, and gravitation, which affect the whole, but in this outline we need not dwell upon dynamics.

We have now to seek for what is common, as a law of order, in all realms, and also for the primary relations between the inorganic and organic worlds. The former is sustentative

to the latter ; and organic realms, in their turn, as is manifest in geological formations, serve to modify and improve the structure of the crust of the earth,—many rocks being mainly formed of fossil shells and other remains of animal or vegetable forms.

The sub-divisions of each realm into classes, sub-classes, alliances, and orders, have not hitherto been made on any common principle of method ; and probably but few zoologists and naturalists admit that such a principle exists, if we may judge from the diversity of views put forth by men of eminence in each department of the subject. We cannot presume to affirm that such a principle of unitary order does pervade all realms ; but we may venture to suggest that it is not improbably the case, and proceed to give an outline of the fact.

In the realm of *Vertebrata*, the most obvious primary distinctions are those of the four classes,—fishes, reptiles, birds, and mammals. And here we remark that three of these classes are *oviparous*, and only one *viviparous*. One main class, then, and three inferior classes, are easily recognised in this realm. Does such a law of sub-division hold in all, or any of the other realms ?

But first we may observe that some zoologists have given the name of class to the sub-classes of reptiles and of fishes established by Cuvier, and this we deem a cause of confusion ; for it is important not to confound the distinction of classes with that of sub-classes.

In the realm of *Mollusca* numerous classes have been formed by different zoologists, and it may seem presumptuous in us to question the propriety of these distinctions, but we venture to suggest that Cephalic Molluscs form one main class in contrast with three inferior classes of Acephalous or Headless Molluscs. According to this view, Gasteropods, Pteropods, and Cephalopods, form three sub-classes only of the one great class of Cephalic Molluscs.

In the *Articulata* realm, Crustacea and Arachnida form sub-classes only of one main class ; and other so-called classes in this realm are only entitled, according to our views of organic method, to the rank of sub-classes. The class of insects alone seems to us quite natural and complete. These

views may be deemed erroneous by eminent zoologists, and we merely suggest the idea of a unitary law in all the realms, without pretending to define it accurately in all cases.

In the realm of *Radiata* various divisions into "kingdoms" and "sub-kingdoms," classes and sub-classes, have been recognised by eminent zoologists; and here, again, we venture to suggest that a primary division into one main class of Echinoderms, and three inferior classes of subradiata, would answer all the purposes of primary natural distinction. We leave the question in the hands of those who are most competent.

The *Phanerogamic realm* of vegetable organism contains one main class and three inferior ones,—one dicotyledonous class of "Exogens," and three monocotyledonous classes of "Endogens." All botanists agree in classing Exogens as a superior class; but some difference of opinion exists concerning the distinction of classes in Endogens. The most simple division, from our point of view, is that of A. de Jussieu, who forms three distinct classes, called *Aquatic endogens*, *Aperianthous endogens*, and *Perianthous endogens*.

The *Cryptogamic realm* has been naturally divided into one superior and three inferior classes. The superior class is that of *Acrogens*; the inferior classes being *Thallogens*. The three classes of the latter type have been well named, *Algales*, *Fungales*, and *Lichenaes*. Hence we see in the organic realms a common principle of distinction between primary and secondary classes; the first stands as *one to three* of the latter, just as the main tissues of the human body stand to the inferior connective tissues of the organism.

Let us now examine the Inorganic realms, which are the sustentative and gravitative support of physical life in the organic world, to see if any similar law of order be discernible in these inanimate realms, so intimately blended with superior cosmic nature. Geologists have recognised four distinct classes of rock formation in the *Geospheric realm*,—namely, "the *Aqueous*, the *Metamorphic*, the *Plutonic*, and the *Volcanic*." The first of these is either solely or mainly connected with organic life, while the other three are simply inorganic. We have then, in this realm, one main

class distinguished from the other three, as in those just mentioned.

In the *Oceanic realm* there is a certain depth of water which is capable of sustaining organic life, while lower depths are unsuited to the respiration of animals and plants. Are there three distinctions of azoic waters, in any way analogous to the hypogene classes of rock formation? Subterranean waters are certainly connected with volcanic action in hot mineral springs, mud salses, and many other varieties of phenomena connected with geology; but these waters may be mainly derived from pluvial sources. The lowest depths of sea, distinct from all volcanic action, and unfit for animal or vegetable respiration, form a class of oceanic strata which may well be classed apart, as having special uses different from those already mentioned. Is there a third kind of strata, set apart for special uses, which would warrant separation as a class in the economy and constitution of the oceanic realm? What shall we say of the Polar frozen strata of the ocean? Do they not form a special class with definite and distinct functions in the permutations and oscillations of relative density and temperature, and the consequent determination and perpetuation of currents in the sea? We have, then, in this realm, as in the Geospheric, one major class of strata and three minor classes,—the major being *synorganic* and the minor simple *inorganic*, in both realms. The different uses of these strata are as manifest as their respective differences of constituent density. The major class alone is *zoothermal*, while the others are azoic. The frozen constitution and peculiar uses of the Polar ice are sufficiently distinct and manifest; and though the special uses of the coldest and the lowest depths of oceanic strata are not so well understood, the difference of density and temperature which renders them unfit for life at once marks the constitution as distinct from that which is replete with living forms. The subterranean seas have their uses in the oscillations of the solid crust of the earth. The generation of enormous powers of gas and steam from these engulfed waters is supposed to be one of the main uses of this class; the gradual upheaval of extensive tracts of land being the result of terrestrial heat acting upon the land-locked

steaming seas. Hence we have four well-defined classes of oceanic strata; and one class is major, while the other three are minor in degrees of rank and uses. Infiltrations of water from pluvial sources have, no doubt, some connection with volcanic phenomena; but it seems not impossible that vast amounts of pent-up steam are the main causes of the gradual upheaval of whole continents.

What of the *Atmospheric realm*? Are there four distinct classes of strata here, as in the Oceanic and the Geospheric realms? There is certainly a primary distinction between the zoic and azoic regions of the air. Organic life is limited to the lowest strata, and this does not extend to more than a third of the entire altitude of the atmospheric ocean. We have, then, a *synorganic* class of strata contrasted with the simply *inorganic* here, as in the other cognate realms. In determining the different strata of the azoic altitudes, we may proceed from the observation of distinct uses to that of constituent form and structure. The Polar regions of the air are subject to the same general conditions of cold as the same regions of the ocean, and for similar purposes of determining and maintaining currents in the atmosphere, as the frozen strata of the ocean serve to perpetuate currents in the sea. Without discussing the question of constituent peculiarities of structure in the air, we may presume, from difference of function, that the Polar regions of the atmosphere differ from the equatorial, as the frozen regions of the ocean differ from the tropical; and that in both cases the Polar strata may be ranked as distinct in character from the other *inorganic* or azoic strata. Whether open seas exist amongst the Polar ice or no, and whether or no such open seas teem with organic life, may be a question for investigation, but the ice itself is certainly azoic. The atmosphere, however, of the Polar regions would not be azoic, if birds and other animals could live and fish in open Polar seas. This class of atmospheric strata is open, then, to doubt, and will require more strict investigation.

From difference of density alone, and the contrast of azoic with organic uses, we find two distinct classes of strata in the ocean; and, from what is known of the increasing density of air from the upper to the lower depths, we may easily con-

ceive a treble series of distinct strata in the atmospheric ocean,—namely, an upper, a middle, and a lower; but this hypothesis of constituent differences of density in structure is barren of result, so long as we have no idea of distinct and definite uses for each. What are the respective uses of the middle and the upper strata? We know the chief uses of the lower and the Polar, but not so well the functions of the other two. These relate most probably to different kinds of action in the relative dynamic powers of heat and light, magnetism and electricity, as manifested in the meteoric phenomena of Polar lights (*Aurora Borealis* and *Australis*); but as we know almost nothing of this branch of science, we will leave the question to those who are competent. Meanwhile, it is not unwarrantably presumptuous to suppose that one organic law of order rules in the constituent form and structure, ends and uses, of the strata in this realm, as we have found it more conspicuously manifest in other realms. The height of the *Aurora Borealis* in (or beyond?) the atmospheric ocean has been estimated variously to be, at times, not more than 50 miles above the earth; at other times, from 80 to 100 miles and more. There is a special use connected with magnetic light, then, in the highest strata of the atmosphere. The highest regions of the clouds do not extend beyond two-thirds of the entire altitude; and in those regions cold is so intense as to act upon the vapours of water in the air, and cause them to condense and fall upon the earth again as rain or hail or snow. By this contrast of temperature and density in the lower and the middle strata of the atmosphere, electrical action is originated for important uses, and therefore we may deem them distinct and separate classes. As in the sea, we have in the air one superior class of zoic, and three inferior classes of azoic strata.

Magnetic luminosity and electric condensation seem to be the most characteristic features of the two upper regions, and these agree in some athermal features with the Polar regions of the atmosphere; whence we designate them as three azoic classes of strata, in contrast with one superior thermal or zoic class.

And now of the subordinate Pluvial and Exuvial realms.

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How are they affected by this law of distribution with regard to forms and uses? Is there one main class with three secondary classes here as elsewhere?

In the *Pluvial realm* we easily recognise ascending mists and vapours, floating clouds, descending rains and dews, hail and snow, running streams and stagnant lakes, glaciers, and snow-beds on the mountain tops. These form an *Aquapluvial* class of meteoric phenomena. There is also a *Gaseopluvial* class, a *Pulveropluvial* class, and a *Lithopluvial* class (fall of meteoric stones, &c.) We need not enter into the details of each, as they are quite distinct and manifest. The first of these classes is decidedly distinct from all the others, and superior in relation to the uses of organic life. Ammonia, marsh effluvia, carbonic acid gas, are useful to the life of plants, but other matters are only useful in a physical and simply inorganic sense. The "red snow," and microscopical organic dust carried by strong gusts of wind over immense tracts of sea and showered down upon far distant lands, is a very interesting and little understood class of what may be called pulveropluvial phenomena. The origin and uses of *aërolites* need not detain us here. The *Pluvial realm* seems unimportant in comparison with the *Atmospheric*, as aqueous vapour and carbonic acid gas together form but one two-hundredth part of the whole mass; but structure and uses are what we look for in all natural distinctions. Organic realms are also unimportant in their mass, though not in structure and development.

Aqueous vapour and rain-water may be said to be the same in elemental structure as the water of the sea, and therefore not entitled to distinction as a portion of a separate realm; but this is not a reason for confounding them in physical constitution and organic method. Articulate animals have vascular, nervous, muscular, and other systems in common with *Vertebrata*, and yet we separate them from each other. The sea is constituted on one general type as a distinct realm, and yet we find four classes of strata, differing from each other in habitual states and uses. The same may be said of the atmosphere and its different altitudes, and also of geological formations.

The Pluvial realm is of a mixed and inferior kind, compared with the seven greater realms; but it is, nevertheless, very important in connection with the sustentation of organic life in animals and plants. It may be inferior in a cosmic view of nature, while it ranks still very high in epicosmic and organic uses. The same may be said of the Exuvial realm, which is not unimportant in a cosmic view, though most important certainly in epicosmic uses.

Evaporation, combustion, and mechanical translation, are the immediate causes of the pluvial phenomena in each class; and these are the effects of heat and light, chemical affinity, and gravitation. Dust-storms and other pulveropluvial phenomena are caused by hurricanes and violent currents of air; and not improbably volcanic eruptions of metallic and non-metallic vapours, carried high up and whirled away to distant parts, may be the origin of many lithopluvial phenomena, or the fall of meteoric stones.

Thus light, heat, electricity, and magnetism, chemical affinity, and gravitation, are the causes of all meteorological phenomena in all the realms of inorganic nature.

The *Exuvial realm* is quite distinct from all the others, as the mere material remains and moulds of living animal and vegetable types of structure. Dead bodies serve as food for living organisms, and as a means of anatomical investigation into the organic forms of nature. They are not living things, but food for living organisms.

The necrological remains of organic bodies form one main class of the Exuvial realm. Secretional exuviæ, such as eggs and milk, fruits, gums, and vegetable juices, form a second class; the moultings of animals and plants, such as the feathers of birds, the wool of sheep, the bark and leaves of trees, and many other kinds of moults, belong also to this class. Honeycombs, birds' nests, the handiworks of man, and such like products, form a third and very natural class of industrial reliquiæ. Fossil remains, petrified or otherwise transmuted in substance, but conserving traces of organic form, constitute a fourth class of Exuvial reliquiæ. One main class, the necrological, and three secondary classes of reliquial forms, may thus be recognised in this subordinate realm.

Anatomy, Palæontology, and Archæology, are mainly interested in the study of this realm, not to mention the cultural arts of industry in producing food for animals and plants.

It is not, however, as dead matter only, but as organic mouldings, that the Exuvial realm is distinguished from the rest ; for the study of matter, merely as such, belongs to the Elemental realm.

The *Elemental realm*.—The realm of matter or elemental substance is distinct from form in organic realms, and also from the physical structure and uses of the inorganic realms. Form and structure, use and function, are alone considered in the Vertebrata, Articulata, Mollusca, Radiata, Phanerogamia, and Cryptogamia, irrespective of the elemental substances contained in any special organism ; and the same may be said of the physical form and structure of the Atmospheric, Thalattospheric, Geospheric, Pluvial, and Exuvial realms. Biology, anatomy, and physiology, alone are interested in the study of organic realms as such ; geology, meteorology, hydrography, physical geography, &c., in the study of the inorganic ; with the exception of the Elemental realm, in which chemistry, mineralogy, and physics, are mainly interested. Matter, as matter, then, and almost irrespective of the Inorganic and Organic realms in which it is subservient to peculiar form and structure, is the subject here to be considered. What is matter, and how many kinds of matter are there in the Inorganic and Organic realms of nature ? For matter permeates all other realms.

Organic substance differs from inorganic in a marked manner, as far as proximate elements are concerned. We have, then, a primary division in this realm as in the others ; and the main difference between the two consists in the extreme mutability and instability of organic matter as compared with inorganic. In the latter, we may easily recognise three secondary classes of substance,—i.e., simple elements, such as gold and silver, oxygen and hydrogen ; artificial compound bodies, such as the products of chemistry ; natural inorganic compounds, such as minerals and crystals of various kinds. The orderly sub-division of these classes is not, perhaps, an easy matter in the present state of chemistry and mineralogy, but

organic compounds have been already more or less distinguished into groups of proximate elements; mineralogists have made various attempts at the systematic arrangements of natural inorganic compounds; and chemists have made certain approximations to what may be deemed a natural arrangement of the simple elements and artificial compounds. Gerhard's unitary system of grouping the elements and chemical combinations seems to be as simple as any; and various systems of crystallography and mineral classification have been suggested by different authors. We need not dwell upon these various methods here, as our present business is merely with the primary divisions of each realm; and in this case, the most natural primary distinction of elemental types seems to be that of one main class of organic, and three secondary classes of inorganic bodies.

The principle of one common law of primary divisions in each realm, as here suggested, may seem arbitrary; and it may, indeed, be really imperfect in more points than one; but is there no necessity for some such method of distinction and classification to complete the numerous shortcomings and perplexing disagreements of inductive method? Is it possible, without a natural standard of perfection as a type of unity, to bring together in one simple whole the endless details of natural science? Experience says it has not yet been possible, for all the leading naturalists of the present age differ from each other and from those of former ages in their methods of arrangement.

We take the human body as a type of organic unity, in which a complex multiplicity of organs is reduced to order in co-operative life and uses, and we *suppose* that one law of order rules in all the complex unities of nature. Is this hypothesis admissible? And can we learn to work it as a method, if it be true in principle? We believe it to be true and not too difficult to analyze, but many failures may occur in application before a perfect method is acquired.

In the present outline the *Elemental realm* may seem to be a superfluous distinction; but it is mainly through this realm that man obtains control over the elements of matter. It would be tedious to argue the question here, and criticism is invited

as a means of testing and improving, or supplanting these views of method.

The *divisions* may seem natural in some realms and forced in others. The *classes* may seem natural where they agree with those already recognised, and arbitrary otherwise. The number four, as here applied, does not seem absolutely necessary, as secondary classes may be more or less numerous in different realms. The only point that seems to be certain, is, that there is one main class in the highest division of each realm, and several secondary classes in the minor division. Our arrangement does not agree exactly with others in either the major or the minor divisions, and we may be as far from the truth as they. Critical investigation will decide. Meanwhile, we may observe that Agassiz, who has written a large octavo volume on classification, admits five classes of Vertebrata,—he suggests eight classes, even,—but only three classes of Articulata, three of Mollusca, and three of Radiata; while Milne-Edwards enumerates five classes of Vertebrata, eight classes of Articulata, six classes of Mollusca, and five classes of "Zoophytes" (Radiata). Other eminent zoologists form different arrangements in their leading and secondary divisions, so that unity is nowhere to be found in the inductive systems hitherto proposed. Inductive method is, in fact, only fit for grouping individual varieties and congeneric series; it has no complete ideal, unit, or conception, as a guide to higher combinations and descending analytical progression, and its various attempts to work from an imperfect standard have led to much confusion and diversity of plans.

Some of the classes established by naturalists may be resolved into sub-classes or anomalous orders only, and numerous modifications are required in many of the leading divisions now diversely formed. We need not enter on that question here, as an illustration of the fact is given in our paper which appeared in the number for January 1862. Our present object is to call attention to the want of a deductive principle of method to complete the work of mere inductive cumulation, and to suggest a critical examination of our own hypothesis. The natural distinctions of realms, and primary divisions in each realm, we deem undeniable; those of classes and sub-

classes, alliances and sub-alliances, require consideration, and difference of opinion on these points may be expected until science has made further progress.

*On the Composition of a Pseudo-Steatite.** By MURRAY THOMSON, M.D., F.C.S., Lecturer on Chemistry, Edinburgh, and Mr MORD BINNEY, Student in Dr THOMSON'S Laboratory.

The mineral which is the subject of this short notice I have ventured on denominating a Pseudo-Steatite; it was found by John Gellatly, Esq., late of the Chemical Works at Bathgate, forming a joint between the masses of a kind of serpentine; which latter rock is esteemed of some value for the construction of certain parts of bakers' ovens, and for which purpose it is quarried close to the village of Blackburn, Linlithgowshire.

Mr Gellatly, while making a visit to this quarry, picked up some pieces of the mineral, and sent them to my pupil, Mr Mord Binney, simply with the view of furnishing material to him for analytical practice, and not at first under any impression that the result of analysis would reveal anything unusual. Mr Binney proceeded with the analysis under my direction; and it was only on the completion of it, and inspection of the results, that Mr Gellatly and myself were struck with the disagreement that seemed to exist between the external characters of the mineral and its chemical composition. As it presented the external characters of a steatite, it was regarded by all who examined it to be a variety of that mineral; but the analysis showed it to contain only a comparatively small quantity of magnesia, which is the characteristic base of the steatites, while at the same time, the alumina had a high per-centage; in other minor features, also, the composition did not correspond with any of the published analyses of steatites.

Having arrival at this result, it was needful, to avoid error, to make fresh analyses, which were accordingly made by Mr

* Read before the Royal Physical Society, 7th May 1862.

Binney and myself independently, and the numbers thereby obtained are those which have been put below side by side with each other. The result of these second analyses in a great measure confirmed the first, though they showed a composition widely different from that of steatites generally.

The typical composition of a steatite is, that it consists of silica, magnesia, with more or less water: these are the usual constituents enumerated; but it will be seen that the mineral we have analyzed differs from that type in containing but little magnesia, a good deal of alumina, and protoxide of iron; along with a diminished per-centage of silica. There is, however, one variety of steatite, called by Haüy "saponite,"* which, by both Klaproth's and Swanberg's analyses, contains considerable amounts of alumina as well as magnesia; but even here the quantity of the former base does not exceed 10, and that of the latter is not set down as less than 25 per cent. To neither of those numbers do the per-centages which we obtained approach; so that from the composition of the mineral, coupled with the following physical characters, we are inclined to think there are sufficient grounds for concluding that it is a new species.

The following are the physical characters of the mineral:— It occurs in irregularly striated masses of a dark-green colour, which here and there changes to a brownish tint; it has generally a dull surface, and when exposed to the air effloresces; fracture uneven; it is easily broken and reduced to powder, which has a green colour. Every part of the masses has the genuine soapy feeling of the steatite. Its degree of hardness is 2.2; as it is hardly scratched by gypsum, but is distinctly so by calc spar. Streak dark greenish grey, and sub-lustrous. It does not adhere to the tongue, has no taste, but has a slightly argillaceous odour, especially when a fresh surface is exposed. The specific gravity is 2.469. Before the blowpipe it is infusible, but changes in colour from green to brown; with borax a yellow head changing to green; with carbonate of soda a persistent dull green.

The results of our analyses are now appended.

* Dana, Ed. 1850, p. 253.

CURRENTS OF THE ATLANTIC OCEAN

by A. Keith Johnston F.R.S.E.

Warm Currents Cold do. Red Black



	Thomson.	Binney.
Silica, ...	41.89 ...	42.78
Protoxide of Iron, ...	6.62 ...	6.31
Alumina, ...	22.05 ...	22.53
Manganese, ...	traces ...	traces
Lime, ...	2.42 ...	2.54
Magnesia, ...	6.16 ...	6.76
Water, ...	20.22 ...	18.68
	<u>99.36</u> ...	<u>99.60</u>

	SiO ₂	RO	R ₂ O ₃	HO
Oxygen ratio,	4	1	2	3

Recent Observations on the Florida Gulf-stream. By
ALEXANDER KEITH JOHNSTON, Esq., F.R.S.E.* (Plate I.)

The Gulf-stream of the Atlantic is the best known, and for its effects on climate and navigation by far the most important, of the vast chain of currents which traverse the expanse of ocean. Flowing through the middle space which at once separates and unites the countries of Europe and North America, it necessarily forced itself on the attention of the early navigators. Columbus was the first to make known the existence of this and other currents, having observed the westerly set of the waters of the Atlantic during his first voyage of discovery in 1492. For thirty years after his time, the route which he discovered and brought into notice was followed by the voyagers of Spain and other countries, till the famous Spanish navigator, Antonio de Alaminos, in 1519, discovered the passages and currents of the Gulfs of Florida and Mexico, and the new ship's course through the "Narrows" of the Gulf-stream and the Bahama Channel. These discoveries changed the entire system of Atlantic navigation, and indicated a route for the homeward voyage from America to Europe which was followed for nearly two hundred years. After Alaminos, many isolated observers recorded their remarks on every part of the Atlantic, but these led to no certain results. The Gulf-stream was still regarded as an

* The substance of this paper was read at the annual general meeting of the Meteorological Society of Scotland in January 1862.

object of interest indeed to the naturalist, but of doubt and dread to the mariner. By degrees, however, new appliances were brought to bear on the question of the direction and the velocity of currents, and the chronometer and the log were being rapidly improved; but it was not till near the end of the eighteenth century when Franklin, in America, and Blagden* in England, ascertained, by means of the thermometer, the true direction of the Gulf-stream, and roughly defined its limits, that endeavours were made to turn its current to the advantage of trade and intercommunication. Benjamin Franklin, thermometer in hand, followed the course of the current from the coasts of America to the Azores and the Bay of Biscay; he gave to the world the first picture or chart of the form and extent of this "river in the middle of the ocean," and by this means reformed again the sea routes of the North Atlantic, especially the voyage from Europe to the United States, which, since his time, has been shortened by nearly one-half.

The immediate result of Franklin's revelation was to direct general attention to the remarkable phenomena of the Gulf-stream; it became the favourite object of observation with voyagers and of study with philosophers, so that the public mind was soon made familiar with its general characteristics; but a special acquaintance with its many peculiarities involved such an amount of research as could not be expected from private and occasional observers. In these circumstances the subject was adopted by the Government of the United States of North America. In 1846 the officers of the "Coast Survey" of that country commenced, and have since carried on, a series of exact and comprehensive observations, more especially on the American or western part of the Atlantic system, which have already conferred great benefits on navigation and explained many obscure appearances in the economy of ocean currents.† Now, the importance of a complete acquaintance with the Gulf-stream in all its phases is so fully recognised, that every

* C. Blagden, M.D., on the heat of the Gulf-stream in *Phil. Trans.* Lond. 1782.

† For the results of these observations, see Maury's "Sailing Directions," 4to, Washington; various years; and his "Physical Geography of the Sea," 8vo, second edition. 1861.

authentic observation regarding its temperature, its velocity, or its limits, is received as a welcome contribution to our knowledge of marine meteorology and navigation.

Before referring to the observations which are the more immediate object of these notes, it may be well to state, briefly, the extent of our previous information on the subject of the Atlantic currents.

Although it derives its name from the Mexican Gulf, the origin of the Gulf-stream must be looked for in the Equatorial drift current which crosses the Atlantic basin in the region of the equator, and which, on nearing the coast of South America, separates into two branches,—one flowing south to the mouth of the river La Plata, under the name of the “Brazil current,” and the other and principal branch passing, in a north-westerly direction, along the coast of Guiana towards the Caribbean Sea, which it enters by many channels. Here it imbibes a portion of the heat which accumulates to its maximum of 88° Fahr. in the Gulf of Mexico. After traversing this crescent-shaped basin, the heated water escapes to the eastward through the Gulf of Florida. This portion, which is called “The Narrows,” flows between Cuba, Florida, and the Great Bahama Bank, with a breadth of about thirty-two miles. At the northern extremity of the Bank, between it and Cape Canaveral, the current quits the Narrows, and enters upon the open ocean at the place called “the Outfall” by the old English navigators. When nearly opposite Charleston, its temperature is 84° Fahr. at the surface, and its rate of motion seventy to eighty miles in twenty-four hours. It now begins to expand, till opposite Cape Hatteras its width is about seventy-five miles, and its temperature 83° Fahr. So far the current retains many of its original peculiarities, preserving much of its high temperature, its velocity, its deep indigo-blue colour, and its saltness; its limits are sharply defined and easily distinguished, and its effects on the weather, the trade, and the colonization of the countries on its borders are fully recognised in the history of the North American States. About lat. 37° it forms a great knee or bend, and changes its direction to nearly due east. The Gulf-stream is now fairly launched on a career which

ultimately extends over 3000 miles, and during which it keeps in constant motion at least one-fourth of all the waters of the Atlantic. Having now no bounding continent on either side, and no limit but the comparatively cold water of the open sea, it spreads out across the ocean, flowing usually to the south of the great banks of Nova Scotia and Newfoundland; but, since it contracts and expands according to the season of the year, it sometimes overflows these banks. Spreading out in a fan-like form towards the east, the current gradually loses its high temperature, till, in the meridian of 50° west, it has fallen to 77° , and 10° farther east to 73° . (See figures on the chart.) At the same time its rate of motion has diminished to fifty-five miles in the meridian of Nova Scotia, and to thirty-five in that of Cape Farewell.

Arrived now at the middle distance between Newfoundland and the Azores, the Gulf-stream sends off several great branches, which flow towards the east, south-east, and north-east. The eastern branch is not always recognisable, although it was observed by Franklin, and since by Sabine, to extend into the Bay of Biscay. The south-eastern branch is much more permanent; it is first observed at about 10° east of the Newfoundland Banks, where it inclines southward in the direction of the Azores, which lie in its middle course. Having passed these islands, among which it originates many minor currents, it trends still more to the southward, and joins the Guinea current, which flows in the same direction along the west coast of Africa, and with which it runs in contact till it nears the Tropic of Cancer, when it turns towards the west and rejoins the Equatorial Drift, whence it originated. In the middle of this aqueous circulation in the still water formed by the eddy of the current is found the "Sargasso Sea," an ocean covered by an immense deposit of sea-weed, brought by the Gulf-stream from the Gulfs of Florida and Mexico.

The north-east branch of the Gulf-stream, which is of more immediate interest, as the cause of the mild climate of the British isles, and the source of our storms, separates from the main stream at the point before referred to, and stretches across the ocean towards Great Britain, where it impinges on the shores of Ireland, the Hebrides, Shetland, and the

Faroe Isles, on its way to the coasts of Norway, where its influence is still so great, that even up to the North Cape, in lat. $71^{\circ} 11'$, its tepid waters keep the harbours open for shipping all the year round, while those of the Baltic, many degrees farther south, but excluded from its beneficial effects by the intervention of the British isles, are frozen during several months.

The great antagonist of the Gulf-stream is the mighty "Arctic Current" of cold water from the Polar regions, which, sweeping down the eastern shores of Greenland, passes Cape Farewell, and shortly afterwards meets and unites with the "Hudson Bay" or "Labrador Current" from the icy sea. The united stream flowing southward, with its freight of ice-fields and icebergs burdened with the debris of splintered rocks, meets the northward-bound water of the Gulf-stream in the region of Newfoundland, where the result of the conflict that ensues between the cold and heated currents is the melting of the greater portion of the ice, and the deposition of a vast amount of soil, which, in the course of ages, has formed the famous cod-fishing banks of Newfoundland; and where the encounter between the corresponding currents of the atmosphere produces the beautiful but treacherous "silver fogs," so much dreaded by the mariner in winter.

There is every reason to believe that a large portion of this cold water, in pursuing its course towards the Equator, now passes as an under-current beneath the Gulf-stream, to which it acts as a kind of cushion or bed, for the heated water does not in any place reach the bottom of the ocean. Evidences of the presence of this cold under-current have been observed in many parts of the Atlantic, in some of which, while the surface had a temperature of 80° , the thermometer, at a depth of five hundred fathoms marked only 57° Fahr. Far south, in the Caribbean Sea, the surface temperature on one occasion was observed to be 85° , while that at a depth of 240 fathoms was only 48° Fahr. But a considerable part of the Arctic current passes partly through the Strait of Belleisle, and partly round the shores of Newfoundland, towards the eastern coasts of the North American States. Along these shores it flows towards the south, keeping at a distance, greater or less

according to the season, the warm waters of the Gulf-stream ; and, besides obvious advantages to the climate and navigation of these countries, it secures the presence of the "sheep's head," and many other excellent kinds of edible fish, which could not exist there if the warm water approached the bays and islets in which they congregate.

It will be observed, that in the foregoing sketch no mention is made of the currents in the vicinity of Iceland. Till very recently, indeed, nothing of a precise nature was known regarding the course of the Gulf-stream or the Arctic current in the higher latitudes of the Atlantic ; but this desideratum has been ably supplied by an extensive series of observations made under the superintendence of Captain Irminger* of the Danish navy, which satisfactorily explain many of the physical peculiarities of that interesting island. From these observations it appears that in about the parallel of 61° north, and between the meridians of 16° and 18° west, the Gulf-stream divides, sending off one branch, as already noticed, to the north-east,† and another towards the north-west. This latter, the newly observed branch, touches the southern shores of Iceland at Portland, whence it flows west to Reikjanes, and thence trending again towards the north, it passes outside of Faxa Bugt at the rate of 4.8 nautical miles in twenty-four hours.

Proceeding northwards, its course is arrested, shortly after reaching the parallel of 66° , by the Arctic current of cold water flowing south-west towards Cape Farewell, in Greenland ; and here the limits of the two currents are so sharply defined, that within a short distance in longitude the temperature, which in the warm northerly current is 49° , is found in the cold southerly current to be no more than 32° , making a difference of 17° Fahr. To the northward of this, in the meridian of 20° or 22° west, the Arctic current forms a loop

* See "*Zeitschrift für allgemeine Erdkunde.*" Berlin, September 1861.

† An expedition despatched by the Swedish Government in 1861 to investigate the physical geography of Spitzbergen, ascertained that the great Gulf-stream, which sweeps past the Norway coast, reaches as far as the shores of that island. We are thus enabled to trace the Gulf-stream some 8° or 9° further north than we were warranted to do by previous observations ; and the details of this expedition will be looked for with much interest.

or bend, and sweeps first in an easterly and then in a southerly direction along the northern and eastern shores of Iceland, till it meets and mingles with the warm current in its north-easterly course.

These observations afford a satisfactory explanation of the origin of the comparatively high temperature of the sea on the west and south-west coasts of Iceland, where the thermometer frequently indicates 50° and 51° Fahr., as contrasted with that of the east coast, where, as shown in the chart, the branch of the Arctic current, before alluded to, flows close in-shore, keeping at a distance the warm north-easterly current, and where, in consequence, on the same parallel of latitude, the temperature sinks to 32° and 33° Fahr., or 18° lower on the east than on the west side of the island. It will be observed from the figures on the chart, that the temperature of the sea on the north of Iceland is much higher near the shore than at thirty or forty miles distance, the difference amounting in some places to 10° or 12° , as in Skagestrands Bugt, where, near the shore, it is 45° , while outside it is 35° , and further east only 33° Fahr.

Captain Irminger endeavours to account for this difference by assuming that, in the months of July and August, when the Arctic ocean is least liable to storms, the warm current, which during the rest of the year is driven by the prevailing south-westerly winds towards the north-east, is then deflected westwards along the northern shores of the island; but this opinion requires confirmation; and it appears more probable that the warm water may reach the bays on the north by the west coast. But since the temperature of the sea has not been ascertained in this quarter beyond the parallel of 66° (where, however, it is as high as $44^{\circ}6'$), the determination of this point must be left to future observers.

Such are the principal results of Captain Irminger's series of observations; and in illustration of the effects produced by this arrangement of the warm and cold currents, he adduces the following facts:—

1. The Greenland ice, which is constantly floating past Iceland, never visits its west and south-western shores, from which it is kept off by the warm water of the Gulf-stream.

2. In Faxø and Brede Bugt the water never freezes, and fishing is carried on all the year round, while the vessel that carries the mail between Havnefiord (near Reikjavik) and England is never hindered, even in mid winter.

3. On the north and east coasts of the island, navigation is often impeded by ice brought down by the Arctic current, the force of which current is so great, that in several instances noted by Dr Scoresby whaling vessels were drifted by it at the rate of thirteen or fourteen miles in twenty-four hours.

4. The usual limit of drift-ice is from forty to sixty miles from the north-west coast of the island, but it occasionally fills the whole space of 160 nautical miles in breadth between the north-west point of Iceland and Greenland.

This drift consists of ice-fields five or six fathoms thick, and icebergs sometimes so large that they have been found grounded in eighty fathoms water. The ice appears first near Cape Nord, and drifts towards the south-west, enclosing the bays between Patriks and Isefiord, rarely passing Fugle Huk (lat. $65^{\circ} 30'$), and bringing with it a degree of cold so intense as to be very injurious to vegetation. The amount of ice-drift, and the consequent degree of cold, vary very much in different years. The years 1384 and 1615 are referred to as seasons of intense cold. In the spring of 1807 the people of the small island of Grimsey, twenty-three miles north of Iceland, travelled over the ice to Ofjord.* In 1826, which is on record as a very cold year, the ice-drift is supposed to have covered an area of 200 square miles. The occurrence of ice on the west coast of Iceland is so very rare, as to lead Captain Irminger to question the statement of Sir John Barrow,† who says, that in 1816, and again in 1817, "ice had broken loose from the opposite coast of Greenland, and floated away to the southward, after surrounding the shores of Iceland, and filling all the bays and creeks of that island." The captain is satisfied that this was not the case, at least in so far as Faxø Bugt and Brede Bugt are concerned.

Between the years 1800 and 1860, the Greenland ice visited

* Ofjord is about thirty miles inland, at the termination of a narrow estuary.

† Voyages of Discovery and Research within the Arctic Regions. London, 1846.

Iceland, for a longer or shorter period, thirty-three times, on each of which occasions the north coast was beset by the drift, especially between Cape Nord and Skagestrand's Bugt; thirteen times it enclosed the entire north coast east to Langaes; fourteen times it kept outside of the north-west fiords, blocking up some of them; thirteen times the ice made its appearance in various quantities on the east coast, and five times greater or smaller masses of ice have been driven from the east coast by Vester Horn and Portland towards the west.*

Captain Irminger assures us that the thermometers used in making these observations were all verified and delivered by himself; that the results are found registered in the log-books of the different vessels employed, and that the captains who made them were intelligent men, who took an interest in the work, and that therefore there can be no doubt of their accuracy.

It is much to be desired that further observations should be made on the temperature of the sea on the north-west coasts of Iceland, in order to arrive at a satisfactory explanation of the cause of the milder climate near the north shores of the island; but in the meantime this may be accepted as a genuine contribution to the facts of one of the most important departments of marine meteorology.

The following interesting notes and observations, made while crossing the Gulf-stream from Halifax to Bermuda in November 1861, have been kindly furnished by the observer, David Milne-Home, Esq., younger of Milne-Graden. "The weather," he says, "was exceedingly stormy, so that the exact line of demarcation between the tepid waters of the stream and the water of the general ocean through which it flows was

* The mean temperature of the sea and the air at Reikjavik, for the four seasons of the year, is shown in the annexed table, from which it appears that the temperature of the sea is at all seasons, except in summer, higher than that of the air, and that the difference on the mean of the year amounts to 2° Fahr. nearly.

Mean Temperature of the Air at Reikjavik, 64° 9' N. Lat.

Winter.	Spring.	Summer.	Autumn.	Mean of the Year.
29.1	37.	53.5	37.9	39.4 Fahr.

Mean Temperature of the Surface of the Sea at Reikjavik.

Winter.	Spring.	Summer.	Autumn.	Mean of Year.
35.	39.4	50.5	41.2	41.5 Fahr.

less distinct than usual." Nevertheless, the registry marks plainly enough when the Gulf-stream was entered and when it was crossed.

Observations from the Log-Book of H.M.S. "Nile."

<i>Tuesday, 19th Nov. 1861.</i>	10 P.M., temp. of air, 47° sea, 46°		
Sailed from Halifax at 3 P.M.	midnight, ...	45 ...	47
<i>Wednesday, 20th Nov.</i>	2 A.M., ...	47 ...	48
Noon, Lat. 41° 12' N.	Noon, ...	52 ...	51
Long. 63° 41' W.	2 P.M., ...	55 ...	54
	6 P.M., ...	54 ...	53
Enter Gulf-stream, . . .	8 P.M., ...	56 ...	62
	midnight, ...	56 ...	64
	4 A.M., ...	57 ...	67
	6 A.M., ...	57 ...	70
	9 A.M., ...	59 ...	71
	10 A.M., ...	57 ...	71
<i>Thursday, 21st Nov.</i>	Noon, ...	58 ..	70
Lat. 37° 43' N.	2 P.M., ...	58 ...	70
Long. 64° 23' W.	6 P.M., ...	59 ...	68
	8 P.M., ...	59 ...	70
	10 P.M., ...	59 ...	70
	Midnight, ...	60 ...	70
	2 A.M., ...	59 ...	69
<i>Friday, 22d Nov.</i>	4 A.M., ...	59 ...	69
Lat. 34° 1' N.	6 A.M., ...	60 ...	70
Long. 65° 41' W.	8 A.M., ...	61 ...	68
Getting out of Gulf-stream,	10 A.M., ...	62 ...	70
	Noon, ...	62 ...	68

Difference in
Degrees
of Fahr.

It will be noticed that on Wednesday, from 2 A.M. till 6 P.M., while in the open ocean, the difference of temperature between the sea and the air never exceeds 1°; but on entering the Gulf-stream at 8 P.M., the difference at once rises 6° in favour of the water; on Thursday at 10 A.M., the difference increases to 14°, and then it gradually decreases, till, on Friday, getting out of the stream, it falls again to 6°.

The writer says,—“In calm weather, the line of demarcation between the Gulf-stream and the waters which border on it can easily be seen, and was well observed when the ‘Nile’ (the flag ship) went to Halifax from Bermuda last May. On that occasion the temperature of the water under the *stern* was above 70°, and that of the water under the *bow* at the same moment was under 40° Fahrenheit. This was at the northern edge of the stream; on the Bermuda side, the difference was less.”*

* During another voyage in H.M.S. “Medea,” from Bermuda to New York and back, Mr Milne-Home says,—“On our return voyage, I find that we took

No circumstance can more clearly demonstrate the definite course which this "river in the ocean" cuts for itself through the surrounding waters than the fact that, within the length of a ship lying across it, the difference in temperature amounted to more than 30° of Fahrenheit, a difference equivalent to that between our mean winter and maximum summer temperature.

The Gulf-stream, as is well known, brings seeds and nuts from the West Indian islands, and deposits them on the coasts of the Hebrides ; and it carries drift-wood to the shores of Iceland, affording a much-needed fuel to the inhabitants of that island, where no timber grows. Its effects on climate are strikingly evinced by the looping of the isothermal lines as they cross the North Atlantic ; thus, for example, the line of 32° annual mean temperature, which, according to astronomical climate or that due to latitude, would cross from America through the middle of the British isles, is borne up to the northern shores of Iceland and Norway. The occasional excessive mildness of our winter temperature has been, we think correctly, attributed to an abnormal extension of the Gulf-stream to our shores, since the effects produced in heat and moisture are precisely such as might have been predicated from the relative positions of the current, the winds, and the islands.

As an illustration of the effects of the Gulf-stream on the shores of the British Isles, we may refer to a table of the comparative temperatures of the sea and air on the West and East Coasts of Scotland, drawn up by the Secretary from four years' observations, 1858-9, 1860-61, by members of the Meteorological Society of Scotland ; the stations being, in the West—Sandwick, Stornoway, Harris, Otter House, Easdale, and Oban. And in the East—Barry, Smeaton (North Berwick), and

four hours, after entering the stream, to reach the warmest portion of it, which was 72° Fahr. ; for four hours more the temperature remained at this height, and then it gradually fell until, seventeen hours after, it came down to 60° , and we were getting out of the stream." . . . "The distance we steamed was 110 miles ; thus we went forty miles to reach the warmest waters ; we remained in them for about thirty miles more, and then went 110 miles before reaching the southern side of the stream. This shows the very sudden increase of temperature on the north side, and the more gradual decrease on the south side, owing probably to the proximity of a tropical climate."

East Linton (Dunbar). From these a diagram was constructed, showing the mean sea and air temperatures for each month of the year, and from which the following results are deduced:—

1st, That the mean annual temperature of the sea on the West Coast is $1^{\circ}1$ Fahr. higher than on the East Coast.

2d, That the mean temperature of the air is $0^{\circ}8$ higher on the West than on the East Coast.

3d, That the temperature of the sea on the West Coast is at its *minimum* in March, when it amounts to . . . 43.5
and that it attains its *maximum* in July . . . 55.

The difference being . . . 11.5

On the East Coast the *minimum* occurs in Feb. . . 41.2
and the *maximum* in July . . . 55.8

Difference . . . 14.6

Hence, that the maximum and minimum occur earlier on the East than on the West Coast, and that the difference between the extreme monthly means is 3° greater on the East than on the West Coast.

4. That the difference between the sea temperature on the east and west is, in winter, greater than the difference of the air temperature; while in summer it is less.

These observations confirm the fact that we are greatly indebted to the Gulf-stream for our mild winter temperature, the difference in favour of the West Coast, on which the tepid current impinges, over the East Coast, being, in Nov., +1.7; Dec., +2.8; Jan., +2.3; Feb., +1.3 *for the air*; and *for the sea*, in the same months—Nov., +3.3; Dec., +3.9; Jan., +3.8; Feb., +2.4 Fahr.

These observations are strengthened and confirmed by the results exhibited in a series of tables prepared by an observer of well-known accuracy, the Rev. Charles Clouston, minister of Sandwick, Orkney.* From these tables, extending over a period of thirty-three years, it appears that “the difference between the mean temperature of February, the coldest month ($38^{\circ}25'$), and that of July, the warmest ($55^{\circ}14'$), is only about 17° ; and that during all that period, the mean temperature of

* Communicated to Admiral Fitz-Roy, and inserted in the 5th number of the Meteorological Papers of the Board of Trade.

any month never fell so low as the freezing point, except in February 1838 and February 1855, when it was respectively $31^{\circ} 31'$, and $31^{\circ} 64'$, and that it was never so high as 60° except in July and August 1852, when it was $61^{\circ} 36'$, and $60^{\circ} 64'$. That the Atlantic moderates the extremes, and that it elevates the temperature of winter more than it depresses that of summer, will be evident, when we consider that in 1857 the Atlantic was about 6° warmer than the mean temperature of the air in January and February, and continued warmer for seven months, being nearly equal in April and August, and colder only in May, June, and July, when the difference did not amount to 2° on an average. In 1858 these differences were still more strongly marked, the mean temperature of the Atlantic being $49^{\circ} 66'$, or $3^{\circ} 46'$ above the air, which it exceeded during ten months, and only fell below it during June and August. This explains also, how there is never frost and snow with west wind, and how, if the wind change to the west during frost, the thermometer speedily rises to 40° and upwards, because we have never yet found the Atlantic to be colder than 43° ." Again, "The mean temperature of the sea for the year is $49^{\circ} 6'$, or $2^{\circ} 2'$ above that of the air and the soil, and nearly 3° above that of our best springs. It is even above the mean temperature of any year yet recorded, and a little above the mean temperature of the sea around the coast of Scotland. This seems one of the strongest proofs that the Gulf-stream reaches the shores of Orkney, or that some stream from a warmer climate, by whatever name it may be called, raises the temperature of the sea beyond what it could be raised by the power of the sun in Orkney, and higher than it raises that of the air, the soil, or the springs. Without such a stream, we are not aware that the mean temperature of the sea in other places exceeds that of all other things showing the mean temperature of the localities. As this stream carries to Orkney, along with its increased temperature, productions of the West Indies, the Gulf-weed, &c., we think it proved, and know no other satisfactory explanation of all the phenomena."

In a manuscript paper* written since the above was printed,

* Transmitted to the Meteorological Society of Scotland, May 1862.

the observer says: "More extensive data corroborate all the former remarks—the mean temperature of the year over a period of five years being $45^{\circ} 74'$, while that of the sea was $48^{\circ} 93'$, or $3^{\circ} 19'$ higher, being warmer than the air during eight months of the year, even to the extent of 6° , 7° , or 8° , in January, February, October, November, and December, and colder only during four months, viz. May, June, July, and August, and then only $1^{\circ} 07'$ at an average;"—"and that even the temperature of the air in the sun is nearly 2° lower than that of the Atlantic."

From the prevalence of south-westerly winds in the North Atlantic, the benefits of the high temperature thus generated are diffused over our islands, otherwise the difference in favour of the West Coast would be greater than it now appears.

The above noted results in reference to Scotland are confirmed by similar observations on the influence of the Gulf-stream on the winters of England and Ireland, collected by Professor Hennessy and Dr Lloyd. (See "Proceedings of the Royal Society of London," 10th June 1858, and the "Atlantis" for July 1858.

Notes on Cuckoo-flowers and the Cuckoo-spit. By JAMES HARDY.*

The Cuckoo's garland consists of several ingredients. They have not been investigated, and what I now present is their first assemblage. The true Cuckoo-flower is *Cardamine pratensis*, the pink or wild rocket of the Borders. "These flower for the most part in April," says Gerard (Herball, p. 261), "when the cuckowe doth begin to sing her pleasant notes without stammering." Stillingfleet says that in 1755 the cuckoo called on the 17th, and the cuckoo-flower was in blow on the 19th of April. The name "*Flos-cuculi*" is traced to Otto Brunfels, 1536, adapted from the "*Gauchblume*" and "*Kukucks-bluhme*" of the Germans. It appears in English, in Lyte's translation of Dodonæus, 1578, as "*Coccow flower*." The Flemish name is "*Cocockbloem*," or

* Read to the Botanical Society, May 8, 1862.

"Coeckoebloem." It is "Göge blomster" in Danish, according to S. Paulli; "Blodeuyn y gôg" in Welsh, but this is modern. "*Lychnis Flos-cuculi*" is another cuckoo-flower, derived from a German source,—the "*Cuculi flos Germanis*" of Tragus, 1552. J. Bauhin (*Hist. Plant.* iii. 348) says the Germans call it "Gauch-blum," "Kuckuck-blumen," and the French, "Fleur du coquu." The Flemish is "Coeckcoeckbloemkens," and Lyte translates it "Cockow gillofers." In the county of Durham, I found "Gilloflowers" was a common name for *Cardamine pratensis*. In Welsh it is "Blodau'r gôg." Shakspeare's Cuckoo-flower, in the mock coronet of the mad Lear, must have been a cereal weed.

"Crown'd with rank fumiters and furrow weeds,
With harlocks, hemlock, nettles, cuckoo-flowers,
Darnel, and all the idle weeds that grow in corn."

The "Cuckoo-flower" of Clare, Miss Baker thinks (*Northamptonshire Words and Phrases*, i. p. 164) is the red-flowered campion, *Lychnis dioica*.

"And oft, while scratching through briary woods,
For tempting cuckoo-flowers and violet buds."

He also names the cuckoo-pint, *Arum maculatum*, the cuckoo-flower :—

"Where peep the gaping speckled cuckoo-flowers,
Prizes to rambling schoolboys' vacant hours."

(*Poems*, p. 8.)

"These harebells all
Seem bowing with the beautiful in song;
And gaping cuckoo-flower with spotted leaves,
Seems blushing of the singing it has heard."

(*Rural Muse*, p. 33)

In Devonshire, according to Mr Halliwell (*Archaic Dictionary*), the harebell, *Endymion nutans*, is called "Cuckoo;" in Dumbartonshire, it is "Gowk's hose" (Jamieson). "Cuckoo's stockings," as a provincial name for the harebell, is mentioned in Howitt's "*Book of the Seasons*," p. 126. The Welsh names are "Esgidiau'r gôg," cuckoo's shoes, and "Hosanau'r gôg," cuckoo's stockings (Thomas Jones); "Bwtias y gôg," cuckoo's boots (Davies' *Welsh Botany*). Canterbury bells has the name of "Gowk's hose" in the south of Scotland.

In Lovell's "Herball," Oxford, 1665, p. 72, Canterbury bells is synonymous with "Cuckoo-flowers or Throat-wort;" but unfortunately, at p. 113, it is arranged as a double ladysmock. The common bell-flower, *Campanula rotundifolia*, in the Gaelic list of Lightfoot's "Flora Scotica," is written Curachd-na-cuaig. This seems to be *Curach na-cuaig*, the cuckoo's boat, although an unlettered Skye man, whom I asked, signified that it was the cuckoo's cap, which would be sufficiently expressive if correct. In Gaelic, *Pinguicula vulgaris*, or butter-wort, is "Brogan-na-cuaig," cuckoo's shoes. The *Orchis mascula* is also a cuckoo-flower. Turner's "Herball," 1551, distinguishes it as "Goukis-meat." It is referred to in Lyte's "Dodoens," 1578, p. 226, as "Cuckowes Orchis," and it is so entitled in the index to Gerard's "Herball" by Johnson, 1636. The name in Wales is "Hosanau'r gôg," the cuckoo's stockings or hose (Davies' "Botanology.") In the "Nomenclator Plantarum" of Benedict Berzelius, in the *Amœnitates Academicæ*, Upsal, 1759, the German "Guckuks-blume" stands opposite to this Orchis. The original Cuckoo's hose may have been the cowslip; but correct application cannot be expected in every instance of popular names. In Lyte's "Dodoens," p. 123, the French names are "Coquu" and "Brayes de coquu," i.e., cuckoo's hose in the modern acceptation. This appears to be from Ruellius, 1537, in whose work the country name is "Cuculi brachula." By others it was written "Bracha cuculi." (J. Bauhin, "Hist. Plant." iii. p. 495; 1651.) In the Flemish Dictionary, "Kilianus Auctus," 1642, both "Brachæ cuculi" and "Braies de cocu" are interpretations for the cowslip. Miege's French Dictionary, 1675, Englishes "Coucou" as primrose. Dr Farmer proposed as the true reading "cowslip-buds" for the "cuckoo-buds" of Shakspeare; but this was unnecessary. Following the old French, it could signify the cowslip, without altering the reading; and there may have been a corresponding name in the common English speech, for we find in the Swedish of the island of Gothland, that the name for the cowslip is "Giök-blomma" (Linn. "Flor. Suecica," first ed., p. 57). Mr Don conjectured ("Hist. of Plants," i. p. 40), that the cuckoo-buds is the *Ranunculus bulbosus*, crowfoot, or buttercup, which

blows in May and June; but if it is identical with the "winking Marybuds" "with golden eyes" (which it may not be), it would rather lead us to some flower carrying the name of the Virgin Mary, such as the *Caltha palustris*, the showy marsh-marigold, which, says Linnæus, conforms in time of flowering with the arrival of the cuckoo in Sweden. Stillingfleet found the marsh-marigold to blow April 7th, and the same day the cuckoo sang ("Select Works," ii. p. 373). The Greek word *Κοκκυξ* signifies cuckoo, and likewise a young fig, and the reason given for it is, that in Greece they appeared together. *Oxalis Acetosella*, the wood-sorrel, bears the vagrant bird's impress in many languages. "It is called of some 'Panis cuculi,' cuckowe-breade, eyther because the cuckowes delight to feede thereon, or that it beginneth to blossome when the cuckow beginneth to utter her voyce." (Parkinson's "Theatrum Botanicum," p. 747.) Ruellius, 1537, gives it that name. In French it is "Pain du cocu," "Pain de coucou;" in Italian, "Pan cuculi;" in old German, "Gouchesampfera;" in modern German, "Kukucksbrot;" other German names are "Gauchklee," "Guckgauchklee," "Kukugsklee" (cuckoo-clover), "Gauchbrot," "Guckgauchbrot," "Guchenlauch," and "Gauchlin;" in Swiss, "Guggersauer;" in Flemish, "Cockoucksbrodt;" in Danish, "Giögebrodt," "Giögemad," "Giögesyre;" in Swedish, "Giökmät," which name in that language, *Vicia Orobus*, shares with it. It is the Anglo-Saxon "Gæces-sure" and the Welsh "Suran-y-gôg;" the "Cuckowe's meat" of Turner's "Names of Herbs," 1548. It is the English Cuckoo-sorrel, Cuckoo-bread, Cuckoo-spice; the Scottish Gowk's-meat; the Border Cuckoo's meat, Cuckoo clover, Cuckoo's sourocks, and the Cuckoo sorrel of the north of Ireland. *Tragopogon pratensis*, goat's beard, has for one of its German names "Gauchsbrodt." "Children," says Tragus, "who eat the root while it is yet tender, are wont to call it 'Gauchbrot,' i.e., the bread of the cuckoo, from the sweetness thereof; and if an Apician only knew how good it was, he would never again prefer his acetarian dainties, to all other herbs and roots." (J. Bauhin, Hist., ii. p. 1059.) *Anagallis arvensis*, the scarlet Pimpernel, is in German, Gauchheil, Gochheil,

and "Jochheil;" and in Flemish, "Guychelheil," gowk or fool's-heal, from Gauch and Guich, a fool; a secondary derivative. The kind of moss called great Golden Maiden-hair, *Polytrichum commune*, is the "Gowk-bear" of Ayrshire. In Sweden, says the "*Flora Suecica*" of Linnæus, it is known as "Guckulijn and "Giökrag." In the same country the rare and beautiful *Cypripedium Calceolus*, our Lady's Slipper, is "Guckuskor." The sweet-scented violet and the pansy are in Gaelic, "Sail-chuach," the Cuckoo's heel. In Irish, the first is "Sail Covagh," according to Threlkeld. "Geckdox," in Gerard's "Herball," *Galium Aparine*, may rank here. "Cocowort," Halliwell renders the Shepherd's purse; but this may be doubted. We have also Gowk's siller, shillings, or sixpences, *Rhinanthus Crista-galli*; and on the Borders, Cuckoo-grass, *Luzula campestris*, "flowering with the primrose and the dog-violet, and pulled by children to give variety to the spring nosegay."

The Cuckoo-spittle, Gowk's-spittle, Cuckoo's-spittens, Frog-spit, Toad-spit, Snake's-spit, or Wood-sear of England and Scotland; Kukukspeichel and Hexenspeichel (Witch's spit) of the Germans; Guggerspeu of the Swiss; Gred-spott (Frog-spit) of the Swedes; Giögespit of the Danes; Trolld-kiaring-spye of the Norwegians; and Crachat de coucou of the French; is a froth discharged by the young frog-hoppers, *Aprophora spumaria*, to defend them from enemies and the overpowering effect of the solar heat. "M. Poupart tells, that as soon as the little creature comes out of its egg, it hastens to some plant, which it touches with the tip of its body, and fastens there a drop of white liquor full of air; it drops a second near the first, then a third, and so on, till it covers itself all over with a scum or froth." These get the name of Gowk-spittles, because they are at the greatest plenty "when the bird gets hoarse, or seems by its voice to have a spittle in its throat." (Mactaggart.) The dates of first appearance are in Berwickshire, May 6, 11, 23, 24; June 8. English dates are June 16, June 2, 21. One writer considers it a kind of hardened dew, another a blight. Sibbald, in his "*Scotia Illustrata*," regards it as an exhalation infecting plants, which speedily corrupts and engenders vermiculi, and unless it is wiped off, it

burns up the plants. The enclosed insect lives on the juice of plants, and is often prejudicial to garden blooms. In Sweden it is said to cause madness in cattle that feed where it abounds. The *Cardamine pratensis* and *Lychnis Flos-cuculi* are favourite depositories of its spume, and some conjecture that hence arises the name of Cuckoo-flowers, by which they are distinguished (Dr Johnston's "Flora of the Eastern Borders," p. 33; Miss Baker's "Northamptonshire Words and Phrases," i. p. 165); but it has already been shown that the name does not belong to our language, and has existed for three hundred years at least. And there are plants that it is noticed to affect as much as it does these. "The experience is, that the froth which they call Woodesare (being like a kind of spittle) is found but upon certain herbs, and those hot ones,—as lavender, lavender-cotton, sage, hyssope," &c. (Lord Bacon "Sylva Sylvarum," p. 104; and Sir Thomas Browne's "Vulgar Errors," p. 237.) But there is a plant that has been gifted with a name, "in respect of that kind of frothy spattle or spume, which we call Cuckoo-spittle, that more aboundeth in the bosomes of the leaves than in any other plant that is knowne," viz., *Silene inflata*, Bladder Campion, which Gerard nominated "Spattling Poppy." This is the English of *Papaver spumeum*, which again is translated from the Greek *Μηχρὸν ἀφρώδες* of Dioscorides, a plant that no one can recognise, but which Gesner thought might be this plant. Gerard's name has not come into common use. Plants besmeared by this insect were formerly considered emblematical of cuckoldom. "There was loyal Lavender," says Green, "but that was full of Cuckow-spittles, to show that women's light thoughts make their husbands heavy heads." The Northumbrian name of the insect is "Brock," and hence, some one told Brockett (Glossary of North-Country Words), the expression, "to sweat like a brock;" but this applies to the badger. Boys take them for the early state of the cuckoo; and Isidore, with all a boy's credulity, tells how at the dog-days they inflict matricidal retribution; for then attaining perfection, they rush upon her in a body, cluster under her wings, and kill her with their bites. (Joh. Johnstoni Thaumato-graphia, p. 250.) Isidore regarded it as the offspring of the

Musical Cicada of the south of Europe. Our countryman, Muffett, in his "*Insectorum Theatrum*," 1634, pp. 122, 132, seems to be the first who had a correct conception of the nature of the "young gowk." The passage has been rendered by Sir T. Browne ("*Vulg. Err.*," p. 237): "Certaine it is, that out of this, some kind of locust doth proceed; for herein may be discovered a little insect of a festucine or pale green, resembling in all parts a Locust, or what we call a Grasshopper." Near Newcastle, the small springing Homoptera, to which class it belongs, are still called Grass Locusts. "Not worth a Gowk-spittle," is a Galloway phrase. (Mactaggart, "*Gallovidian Encyclopædia*.") "Gesner asketh, how any man dare be so foolish or venturous as to eat of a cuckoe, whose much spitting argueth a corrupt and excremental flesh." (Muffett's "*Health's Improvement*," p. 99.)

Notice of Flowering Plants and Ferns collected on both sides of Davis Straits and Baffin's Bay. By Mr JAMES TAYLOR, Aberdeen.*

The plants named in the following list were collected by me in the course of five voyages made to Davis Straits, &c., as surgeon on board whaling vessels in the years 1856-61. Some of these years were more favourable for making such collections than others. My time was often very limited, and the ground I could explore much circumscribed by the short stay of the vessels at particular localities. The vessels usually remained longest in Cumberland Gulf, and accordingly the districts round about it have been most completely investigated. But with longer time and more means at my disposal for making protracted excursions into the interior, I have no doubt that the subjoined list could be very greatly increased. I have here given only the flowering plants and ferns. I collected a great many mosses and lichens, but they have not yet been thoroughly examined. On the east side of Davis Straits and Baffin's Bay, I have had opportunity of exploring parts of the country from Disco Island to Wilcox Point; and on the west side my observations have extended,

* Read before the Botanical Society of Edinburgh, 13th March 1862.

with some intervals, from Cumberland Inlet to Cape Adair, a little north of Scott's Bay. It may be explained, that in the list, E. or E. side means Danish Greenland, and W. or W. side, the islands lying to the west of Davis Straits and Baffin's Bay, forming part of the Arctic islands of North America; also, when any particular place is named, it is to be understood as including the district surrounding it. To obviate the necessity of giving latitudes and longitudes in the list, it seems advisable to give here the latitude and longitude of the principal places therein named:—

East side.	N. Lat.	W. Long.
Disco Island, ...	69° 10' ...	54° 30'
Hassen, or Hure Island, ...	70° 30' ...	54° 15'
Dark Head, or Svarthuk, ...	71° 40' ...	56° —
Upernavik, ...	73° 25' ...	57° 26'
Wilcox Point, ...	74° 18' ...	58° 8'
West side.		
Cape Enderby, ...	63° 45' ...	64° 30'
Cape Mercy (of Davis), ...	65° 10' ...	64° 40'

According to the maps, the latitude and longitude of these two places are—Cape Enderby, lat. 63° 45', long. 67°; Cape Mercy, lat. 65°, long. 63° 20'.

Niatolik (Nawaktolik), ...	65° 50' ...	65° (68°?)
Cape Searle, ...	67° 20' ...	62° 30'
Scott's Inlet, ...	71° 10' ...	71° —
Cape Adair, ...	71° 20' ...	72° —

The Kickertine Islands, and the islands called Midliattwack, are in the middle of Cumberland Gulf. They are composed of metamorphic rocks, which rise in Midliattwack to the height of 557 feet, and in the Kickertines to that of 450 feet. These measurements, as well as those given in the list, were all made by means of the aneroid. To give an idea of the temperature of an ordinary fine day in these latitudes, and show the conditions under which Arctic vegetation makes so rapid a growth, I subjoin the temperature on one of the Kickertine Islands at various altitudes, on the 20th August 1861, when there was a clear sky, a bright sun, and little wind:—At 50 feet, exposed thermometer 69° Fahr.; in shade, 48°·5; sunk 1½ foot in soil, 45°; water of a small lake, 58°. At 100

feet in a valley, exposed thermometer, 70°; in shade (a little more wind), 46°; sunk 1½ foot, in somewhat moist soil, 44°. At 200 feet, exposed thermometer, 58°; in shade, 51°·5; sunk 1½ foot in sandy soil, 45°. At 450 feet, exposed thermometer, 62°; in shade, 41°; sunk 9 inches in sandy soil, 48°. Also, at one of these islands a thermometer was sunk 22 inches in a gravelly soil, and examined every two hours for twenty-four hours. The mean of all the observations was 42°·38.

The following is a list of the flowering plants and ferns collected :—

Ranunculaceæ.

Ranunculus affinis, Br.—Flowers in August. Coast to 500 feet. Soil granitic. W. side, at Kingnute, Cumberland Gulf. Grows to about the height of 18 inches.

R. nivalis, L.—Fl. in June. Sea to snow-line. Perennial; on any soil, but most luxuriant on volcanic. E. and W.

R. hyperboreus, Rottb.—Fl. June and August. Alt. 200 feet. E., Disco, Dark Head, and Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair. Grows in small pools of water, the depth of which modifies its appearance.

R. pygmaeus, Wahl.—Fl. June to August. Range same on both sides. Alt., Sea to 1000 feet. Any soil, and grows in small tufts of from 6 to 12 plants. E., Disco and Hassen Islands, Dark Head, Danish Head, and Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

R. sulphureus, DC.—Fl. June to Sept. Range as in last species. Alt., Sea to 200 feet. Any soil. Flower often white, and the whole plant is often under the snow, except the flower stalk; petals very deciduous, and the seeds are often not shed till next spring. E., Dark Head and Danish Head. W., Kingnute, Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

Papaveraceæ.

Papaver nudicaule, L.—Fl. June to Sept. Alt., Sea to 1500 feet. Any soil, but chiefly on glacier drift, of a clayey nature; and amongst animal refuse, where Esquimaux huts have been. Flower sometimes of an inky blue colour, with yellow flowers often on the same plant. The natives appear to make no use of this species. Common on both sides.

Cruciferae.

Arabis alpina, L.—Fl. June to Sept. Alt., Sea to 500 feet. Range limited to the following localities; on trap in loose soil, and associated with few other plants. E., Disco, Dark Head. W., Cape Searle.

Cardamine bellidifolia, L.—Fl. June to Aug. Range 64° to 74°. Alt., Sea to 1500 feet. Mossy soil, amongst *Sphagna*, *Cyperaceæ*, &c. E., Disco and Hassen Islands, Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

U. pratensis, L.—Fl. June and July. Alt., 200 feet. E., Disco.

Draba glacialis, Adams.—Fl. June. Alt., 500 to snow-line. On

trap soil, growing singly, with long filiform roots running deep into the soil; appearance much modified by elevation and exposure. E., Dark Head. W., Cape Searle.

D. hirta, L.—Fl. June to Aug. Alt., Sea to 2000 feet. In common with some other *Drabas*, it sends up two sets of flowering stems, in the earlier and later parts of the season respectively; the siliculæ of the latter generally retaining their seed during the winter. E. Dark Head, Upernavik, Horse Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair.

D. rupestris, Br.—Fl. June to Aug. Alt., Sea to 1000 feet. On any rocky and granitoid soil. E., Dark Head, Danish Head, Wilcox Point. W., Kingnute, Cumberland Gulf, Capes Searle and Adair.

D. muricella, Wahl.—Fl. June and July. Alt., Sea to 500 feet. Soil granitoid. Perennial. E., Wilcox Point. W., Cape Searle, Scott's Bay.

D. stellata, Jacq.—Fl. June and July. Soil granitic. E., Wilcox Point.

D. lapponica, DC.—Fl. June, July. Alt., 1000 feet. Soil granitoid. Very variable. E., Wilcox Point, Dark Head. W., Cape Searle, Scott's Bay.

Vesicaria arctica, Rich.—June. Alt., 500 feet. Soil granitic. Roots sinking deep. E., Wilcox Point.

Cochlearia officinalis, L.—Fl. June to Aug. Alt., Sea to 200 feet. Grows very profusely. The varieties *fenestrata*, *arctica*, and *anglica* are not so common. E., Hassen Island, Dark Head, Upernavik, Horse Head, Duck Islands, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

Caryophyllaceæ.

Silene acaulis, L.—May to July. Alt., Sea to snow-line. Common on both E. and W. sides.

Lychnis apetala, L., and varieties.—Fl. June and July. Alt., Sea to 1000 feet. Any moist soil. Some specimens are but an inch in height, and covered with long hairs; others nine inches, branching freely, and glabrous; flowers pink or white, the former colour most frequent on trap soils, where also the whole plant had a reddish appearance; the latter on granitic soils, the plant being of a dark green. E., Wilcox Point. W., Cape Searle, Midliattwack, and Niatoling.*

L. alpina, L.—June and July. E., Disco.

Honkeneya peploides, Ehr.—July, Aug. Alt., Sea to 50 feet. On the coast, but was also collected about three miles up a river, at the Winter Harbour, Kingnute, on an old sea beach, now raised about twenty feet above spring tides; while it also grew on the present beach, just below, in plenty. W., Kingnute, Cumberland Gulf, Kickertine Island, Cape Searle.

Arenaria verna, L., var. *rubella*, Br.—Fl. June to Aug. Alt., 500 feet (?). Soil granitic. In crevices of rocks. W., Winter Harbour, Kingnute, Cumberland Gulf.

A. Rossi, Br.—July, Aug. Alt., 200 to 1000 feet. Most frequent in trap soil, moistened by melting snow. E., Hassen Island, Dark Head. W., Kickertine Island, Cumberland Gulf, and Cape Searle.

* Niatoling is the name applied to the *districts* round the station of Niatolik.

A. arctica, Stev.—July, Aug. Alt., Sea to 1000 feet. On any soil. E., Dark Head, Upernavik, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

Stellaria Edwardsii, Br.—July, Aug. Sea to 500 feet. Soil granitic. W., Winter Harbour, Kingnite, Kickertine Island, Niatolik, Cumberland Gulf.

S. stricta, Br.—June to Aug. Sea to 500 feet. Found in great profusion about the ruins of Esquimaux settlements. E., Women's Island, Duck Island, and Wilcox Point. W., Cape Searle, Scott's Bay, and along the coast.

S. longipes, Goldie.—July, Aug. W., Niatolik, Cumberland Gulf.

S. humifusa, Rottb.—July, Aug. Plentiful in sandy beaches. E., Dark Head, Women's Island. W., Capes Adair, Searle; Kickertine Island, Cumberland Gulf.

S. lœta, Rich.—July, Aug. W., Niatolik, Cumberland Gulf, Cape Searle.

Cerastium alpinum, L.—May to Aug. Sea to snow-line. Varieties not unfrequently occur. Very common on both sides.

C. trigynum, Fries.—July. Alt., 1000 feet. E., Disco.

Rosaceæ.

Dryas octopetala, L. (*integrifolia*, Vahl).—June, July. Alt., 1000 feet. E., Disco, &c. W., Cape Searle, Cumberland Gulf, &c.

Potentilla tridentata, L.—July, Aug. Alt., 300 feet. In crevices of granite rocks. W. Niatolik, Midliattwack Islands, Cumberland Gulf.

P. emarginata, Psh.—July, Aug. Alt., 500 feet. W., Niatolik, Kickertine Island, and Kingnite, Cumberland Gulf.

P. nivea, L.—June to Aug. Sea to snow-line. The specimens sent to Professor Balfour did not appear to him to be the true *nivea*. Are they nearer var. *pulchella* of Br.? E., Dark Head, Women's Island, Horse Head, Wilcox Point. W., Kickertine, Midliattwack, Niatolik Islands, Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

*P. Vahlia*na, L.—July, Aug. Coast to snow-line. A very variable plant, giving rise to many of the varieties of authors. Thus, *P. sericea* seems a two-flowered form, while *P. hirsuta*, Vahl., and *P. Jamesoniana*, Grev., are also varieties of it. E., Hassen Island, Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

Onagraceæ.

Epilobium alpinum, L.—July. E., Disco.

E. latifolium, L.—June to Aug. Alt., 1000 feet. Any soil; spreads much, but in some places seldom flowers. In warm valleys, in a southern exposure, it grows luxuriantly; in such places, I have several times found the exposed thermometer to indicate 80° to 90°. The highest temperature I ever observed in these regions was 106° Fahr. E., Hassen Island, Dark Head, Women's Island, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

E. angustifolium, L.—Aug., Sept. Alt., 1000 feet. Only found in the locality indicated, where it occupied a large space of ground amongst *Salix arctica*. W., North side of Winter Harbour, Kingnite, Cumberland Gulf.

Haloragaceæ.

Hippuris vulgaris, L.—Fl. Aug. Range limited. Alt., 100 feet. In small pools, to a temperature of 56° Fahr. W., Kickertine Islands, Cumberland Gulf.

Saxifragaceæ.

Saxifraga oppositifolia, L.—Fl. May to July. Alt., 1500 feet. E., Disco, Hassen Islands, Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, &c.

S. tricuspidata, Retz.—Fl. June to Sept. Alt., Snow-line. Any soil, and may reach a foot in height. E., Disco, Hassen Islands, Dark Head, Women's Islands, Horse Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair.

S. aizoon, Jacq.—Aug., Sept. Alt., 300 feet. In clefts of granitic rocks. W., Kingnite, Midliattwack Islands, and Niatoling in Cumberland Gulf.

S. nivalis, L.—Fl. July, Aug. Alt., Coast to 1000 feet. Best in damp soil, mossy. E., Dark Head and Wilcox Point. W., Cumberland Gulf, Scott's Bay, Cape Searle.

S. cernua, L.—Aug. Coast to 200 feet. By the sides of rivulets, amongst mosses, &c. W., Kickertine Islands, Kingnite, Cumberland Gulf, Scott's Bay.

S. rivularis, L.—July, Sept. Coast to 2000 feet. Any soil, but varies in height from 1 to 6 inches, and often flowers twice a-year. E., Hassen Island, Dark Head, Women's Island, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

S. caespitosa, L.—June to Aug. Coast to snow-line.

The following varieties occur:—

1. Leaves variable, the cauline ones entire.
 2. Leaves tripartite and cuneate.
 3. Leaves of both forms, and in 2 or 3 flowers on the same stem.
- Common on both sides.

S. hirculus, L.—Aug. Alt., 100 feet; on clay soil; it grows singly. W., Scott's Bay.

S. stellaris, L.—Aug. Alt., 200 feet. On granite, and often viviparous. W., Kickertine Island, Cumberland Gulf.

S. foliolosa, Br.—July. E., Disco.

S. hieraciifolia, W. & K.—Aug. Alt., 100 feet; on moist granitoid soils. W., Banks of a river south of Scott's Bay.

Chrysosplenium alternifolium, L.—Aug., on the beach amongst mosses. W., Midliattwack Islands, Cumberland Gulf.

Compositæ.

Gnaphalium sylvaticum, L.—June to Aug. Alt., 1000 feet. Any soil; very variable. E., Dark Head, Women's Islands, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

Antennaria alpina, L.—June to Aug. Alt., 1000 feet. Professor Balfour has doubts whether this be *alpina*. W., Kingnite, Kickertine, Midliattwack Islands, Cumberland Gulf.

Arnica montana, L. (*angustifolia*, Vahl).—June to Aug. Alt. 500 feet. Varies much; height, 1 inch to 1½ foot; is smaller in trap

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than in granitic soils. E., Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle.

Artemisia borealis, Pallas.—June to July. Alt., 500 feet. In crevices of rocks. W., Kingnite, Cumberland Gulf.

Erigeron uniflorus, L.—July to Aug. Alt., 700 feet. Varies much in size. Largest specimens, 18 inches. E., Hassen Island, Dark Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair, Scott's Bay.

Taraxacum pa'ustre, DC.—July, Aug. Sea to 500 feet. E., Disco, Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle.

Campanulaceæ.

Campanula linifolia, Hænk.—Aug., Sept. Alt., 500 feet on granitic soils. W., Cumberland Gulf, Cape Searle, Scott's Bay.

C. uniflora, L.—June to Aug. Alt., 500 feet. There seem to be two varieties of the plant. E., Disco, Hassen, Dark Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair.

Vacciniaceæ.

Vaccinium uliginosum, L.—Fl. May, June. Sea to snow-line; often covers large spaces, singly or associated with *Cladonia rangiferina*. The large and juicy fruit was abundant wherever I saw the plant. Common on both sides.

V. Vitis-Idæa, L.—May, June. Alt., 500 feet. E., Wilcox Point.

Ericaceæ.

Cassiopei tetragona, Don.—July, Aug. Alt., Snow-line. Occurs everywhere, like the *Calluna* of Scotland, and made a fire for us at night when travelling, besides an excellent couch under the shelter of a boulder—no unnecessary luxuries in my longer journeys inland to the West of Cumberland Gulf, &c. Common on both sides.

C. hypnoides, Don.—June, July. Alt., 50 feet. In sandy flats on the coast, in dense masses. W., Kingnite, Kickertine Islands, Niatoling, and Cape Searle, Scott's Bay.

Azalea procumbens, L.—June, July. Alt., 500 feet. E., Wilcox Point.

Ledum palustre, L.—Aug. Mossy soil. Has a powerful odour, and is hence used by the natives in packing and preparing their seal skins; also used as tea. E., Dark Head, Women's Islands, Horse Head, Wilcox Point. W., Cumberland Gulf, Capes Searle and Adair, Scott's Bay.

Andromeda polifolia, L.—July. Mossy soil. E., Disco, Wilcox Point.

Menziesia (Phyllodoce) cærulea, L.—July, Aug. Alt., 300 feet. In granitic and mossy soils, with *Ledum*. E., Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle.

Rhododendron Laponicum, L.—June, July. Alt., 1000 feet. Often covers large spaces, flowering in great profusion; more frequent on the E. side. E., Disco, Hassen and Women's Islands, Dark Head, Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

Pyrola rotundifolia, L. (*chlorantha*, Sw.)—Aug. Very common on any soil; specimens occur with only one flower. Common on both sides.

Diapensia Lapponica, L.—July, Aug. Sea to 500 feet. The withered leaves of former years remain on the stem, closely packed below the living ones. Often grows on exposed plains, and on dry soil. Common on both sides.

Boraginaceæ.

Mertensia maritima, Don.—July, Aug. Beach, amongst sand. W., Cape Searle.

Scrophulariaceæ.

Pedicularis arctica, Br.—July, Aug. Sea to 500 feet. E., Dark Head, Wilcox Point. W., Cape Searle.

P. Kanei, Durand.—July, Aug. Sea to 1000 feet. Trap soil. E., Hassen Island, Dark Head, Horse Head. W., Cape Searle.

P. hirsuta, L.—June, July. Alt., 800 feet. The most common of the genus. E., Disco and Hassen, Women's Islands, Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

P. Langsdorffii, Fischer.—June, July. Alt., 500 feet. E., Dark Head, Wilcox Point. W., Kingnite, Cape Searle, Scott's Bay.

P. Nelsoni, Br.—June, July. Alt., 300 feet. W., Kickertine Islands, Midliattwack, Cumberland Gulf.

P. Lapponica, L.—June, July. E., Disco.

Euphrasia officinalis, L.—July, Aug. Sea to 50 feet. The plants were very small. W., Kingnite, Cumberland Gulf.

Plumbaginaceæ.

Armeria vulgaris, Willd.—July, Aug. Sea to 500 feet. Only seen at Cape Searle, in trap soil. W., Cape Searle.

Polygonaceæ.

Polygonum viviparum, L.—June to Aug. Coast to 500 feet. Common on both sides.

Oxyria reniformis, Hook.—June to Aug. Sea to snow. Very common, but not used by the natives as a cure for scurvy, for which they use the stomach of a recently killed deer. Common on both sides.

Kœnigia Islandica, L.—July, Aug. 50 to 500 feet. On the ground moistened with water from melted snow, and in moist crevices of rocks. W., Cape Searle, Midliattwack Island, and Kingnite, Cumberland Gulf. Annual.

Empetraceæ.

Empetrum nigrum, L.—May, June. Reaches snow-line. Very common in some places, and with fine fruit, which often survives the winter. In autumn its berries, with those of *Vaccinium uliginosum*, are collected and eaten by the natives. These are also eaten by *Corvus corax*, var. *Americanus*, and *Plectrophanes nivalis* and *P. lapponica*; while the grouse are fond of the young twigs. Common on both sides.

Betulaceæ.

Betula nana, L.—June. Not seen N. of Disco, nor on the west side. E., Disco.

Salicaceæ.

Salix arctica, Br.—May, June. Alt., 1500 feet. The tallest plant

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seen was 4 feet in height; it often grows to a considerable size, spreading over the southern face of some boulder. Common on both sides.

S. reticulata, L.—May, June. Alt., 500 feet. E., Dark Head, Wilcox Point. W., Scott's Bay.

S. herbacea, L.—May, June. Coast to snow-line. Covers extensive tracts, and that too where most other plants cease to appear, except *Junci* and *Luzula*. The grouse feed on the leaves in spring. In dry fine weather in September, I have often seen its downy seeds wafted in clouds over land and sea. Common on both sides.

S. vestita, Pursh.—May, June. Alt., 200 feet. W., Niatolik, Cumberland Gulf.

S. desertorum, Rich.—May, June. Alt., 100 feet. W., Kingnite and Scott's Bay.

S. arbutifolia, Sm.—May, June. Alt., 200 feet. Detected by Professor Balfour. W., Kickertine and Midliattwack Islands, Cumberland Gulf. Frequent.

Melanthaceæ.

Tofieldia palustris, L.—June. Alt., 500 feet. Mossy soil. E., Wilcox Point. W., Kingnite, Cumberland Gulf, Cape Searle, Scott's Bay.

Juncaceæ.

Luzula spicata, Desv.—June, July. Alt., 100 feet. W., Niatolik, Kickertine Islands, Kingnite, all in Cumberland Gulf.

L. spadicea, DC.—June, July. Alt., 100 feet. In marshes amongst *Sphagna*. W., Kickertine, Kingnite.

L. arcuata, Hook.—July, Aug. Coast to snow-line. The seeds of this and other *Luzula* often survive the winter, being suddenly covered with snow, and thus afford a supply of food in spring to many birds in their northward migration, while they are equally serviceable in autumn on their return. Frequent on both sides.

L. hyperborea, Br.—July, Aug. Reaches snow-line. The leaves and stems of succeeding seasons often remain on the same plant, and from their size, &c. in a measure indicate the character of each season. Common on both sides.

L. campestris, Br., v. *congesta*.—July, Aug. Alt., 200 feet. W., Cumberland Gulf, in various places.

Juncus biglumis, L.—June, July. Coast to snow-line. Common on both sides.

J. castaneus, Sm.—June, July. Alt., 150 feet. Grows where water has stood in the early part of the year. W., Cumberland Gulf, in various places.

J. arcticus, Willd.—Aug. Alt., 100 to 150 feet. Mossy soil. W., Midliattwack Islands, Cumberland Gulf, Scott's Bay.

Cyperaceæ.

Eriophorum capitatum, Host.—June, July. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

E. angustifolium, Roth.—June, July. Coast to 300 feet. Common on both sides.

Carex rigida, Good.—June, July. Coast to snow-line. E., Wilcox Point. W., Cape Searle and Scott's Bay.

C. nardina, Fries.—July, Aug. In dry, stony places, like a dead tuft of grass. W., Cumberland Gulf, var. loc., Cape Searle.

C. misandra, Br.—July, Aug. W., Kingnute, Cumberland Gulf.

C. saxatilis, L.—July, Aug. Alt., 500 feet. Grows in marshes. E., Wilcox Point. W., Scott's Bay.

C. vulgaris, L.—June, July. Coast to 300 feet. W., Cumberland Gulf.

C. glareosa, Wahl.—June, July. At the sea level on the sandy beach, in large circular tufts. W., Cumberland Gulf, var. loc.

C. Stans, Drej.—June, July. Sea, 1500 feet. On the sandy shore this plant is so stunted as to seem very different from specimens at higher elevations and more favourable situations. E., Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

C. fuliginosa, Hoppe.—July, Aug. Coast to 500 feet. On exposed plains. E., Wilcox Point. W., Cumberland Gulf, Wilcox Point.

C. compacta, Br.—June, July. Coast to 200 feet. Very common, and grows amongst mosses in marshes. Specimens nearly 2 feet high seen. E., Dark Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

C. aquatilis, Wahl.—July, Aug. In bogs. E., Disco.

C. leporina, L.—June, July. Alt., 200 feet. In marshes amongst mosses. W., Kickertine Islands, Cumberland Gulf.

C. capillaris, L.—July, Aug. Alt., 1000 feet. On granite cliffs. W., Cumberland Gulf, var. loc.

C. serpoides, Mich.—June, July. On granite cliffs. E., Women's Islands, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

C. VahlII, Schkh.—June, July. Coast, 500 feet. In mossy soil, and about the edges of bogs. W., Cumberland Gulf, var. locis.

C. rariflora, Smith.—June, July. Coast to 500 feet. In marshes. W., Cumberland Gulf, various localities.

Gramineæ.

Alopecurus alpinus, Sm.—June to Aug. Most plentiful about old Esquimaux settlements; greatest height 2 feet. Common on both sides.

Calamagrostis canadensis, Nutt.—Aug. W., Cape Searle.

Agrostis vulgaris, L.—Aug. Alt., 200 feet. On both dry and moist cliffs. W., Cumberland Gulf.

A. rupestris, Willd.—June, July. Alt., 50 feet. On dry rocky soil. W., Midliattwack Islands, Cumberland Gulf.

Hierochloa alpina, Br.—July, Aug. Reaches the snow-line. A very common Arctic grass; greatest height 2 feet. Common on both sides.

H. pauciflora, Br.—June, July. Sea to 100 feet. On sandy soil by rivers, &c., and on the coast. W., Cumberland Gulf, var. loc.

Poa alpina, L.—Aug. Alt., 1000 feet. W., Cumberland Gulf, var. loc., Cape Searle, Scott's Bay.

P. arctica, L.—July, Aug. Coast to snow-line. Perhaps the commonest Arctic grass, and would often form fine pasture. Common on both sides.

P. cenisia, All.—July. Alt., 500 feet. W., Kickertine and Midliattwack Islands, Cumberland Gulf.

P. Balfourii, Parn.—July. Alt., 500 feet. On cliffs of granite. W., Kingnite, Cumberland Gulf, Cape Searle.

P. angustata, Br.—July. Alt., 50 feet. Confined to the coast, on sandy soil. W., Cumberland Gulf, var. loc.

Festuca ovina—June, July. W., Kingnite, Cumberland Gulf.

F. brevifolia, Br.—July. Coast to 1500 feet. Very common on any soil. Common on both sides.

F. Richardsoni, Huds.—July. Coast to 500 feet. On granitic soils. W., Midliattwack Islands, in Cumberland Gulf.

Elymus arenarius, L.—July, Aug. E., Disco.

E. mollis, Br.—Aug., Sept. Sea level, on sandy soil. W., North side of Winter Harbour, Kingnite.

Colpodium latifolium, Br.—July, Aug. Coast to 500 feet. In marshes and in sandy soil. Common on both sides.

Phippsia algida, Br.—June, July. Coast to 100 feet. In marshes. A very common grass. Common on both sides.

Trisetum subspicatum, Beauv.—July, Aug. Coast to snow-line; very common, growing sometimes $2\frac{1}{2}$ feet high. Common on both sides.

Dupontia Fischeri, Br.—July. Sea to 50 feet—soil sandy. W., Cumberland Gulf, var. loc.

Pleuropogon Sabinei, Br.—July, Aug. Coast to 200 feet. Grows in pools of water, in any kind of soil. It is perhaps the finest of Arctic grasses; its leaves float on the surface, the culm rising from 9 inches to 1 foot above the water, bearing its beautiful purple florets. W., Cumberland Gulf, Cape Searle, Scott's Bay, Cape Adair.

Filices.

Woodsia ilvensis, Br.—July, Aug. Range limited. Alt., 100 to 500 feet, on granitic rocks. I have not found this nor any other of the Ferns descend below 100 feet. W., Niatolik, Kingnite, Cumberland Gulf, Cape Searle.

W. hyperborea, Br.—July, Aug. E., Dark Head, Women's Islands, Wilcox Point. W., Niatolik, Kingnite (very abundant), Cape Searle, Scott's Bay, &c.*

W. glabella, Br.—July, Aug. Range more limited than the last, not abundant in some localities. E., Horse Head, Wilcox Point. W., Cumberland Gulf, Cape Searle, Scott's Bay.

Cystopteris fragilis, Bernh.—July, Aug. A fern of great beauty and of rapid growth; ascends 100 feet higher than the other species. The most characteristic specimens of the var. *dentata* were found growing among the dead roots of *Salix arctica*, on the N. side of Winter Harbour, Kingnite, in Cumberland Gulf. E., Disco, Women's Islands, Wilcox Point. W., Kickertine Islands, Kingnite, Cumberland Gulf, Scott's Bay.

C. alpina, Desv. (?)—I have generally brought home with me in a living state the roots of such plants as seemed most eligible for cultivation; and with a little care and experience in packing, this practice affords very satis-

* None of the roots brought home have developed into *W. hyperborea*. They have all turned out to be either *W. ilvensis* or *W. glabella*, though the fronds brought home corresponded with *W. hyperborea*.

factory results, as in the hands of Mr John Roy, sen., nurseryman, and the Rev. Mr Beverly.*

Equisetaceæ.

Equisetum arvensis, L.—Only seen barren. Alt., Coast to 500 feet. E., Disco, Dark Head, Wilcox Point. W., Cumberland Gulf, Scott's Bay.

E. variegatum, Schleich.—Only seen barren. Alt., 100 feet. Soil granitic. W., Inland from Cape Searle.

Lycopodiaceæ.

Lycopodium annotinum, L.—Aug. Only seen once, and at an elevation of 200 feet. W., North side of Winter Harbour, Kingnite, in Cumberland Gulf.

L. alpinum, L.—Coast to snow-line; seen in all parts of these regions visited by me. Common on both sides.

Rambles of a Naturalist in India, and the Western Himalayan Mountains. By A. LEITH ADAMS, Esq., M.D.

I. *Excursion to the Salt Mountains of the Punjab.*

During the months of March and April the climate of the Northern Punjab is delightful. If the heat at mid-day is oppressive, the mornings and evenings are always cool and pleasant.

My old friend and companion Young joined me in this, as in former expeditions, for the purpose of hunting wild sheep, and procuring specimens of game-birds for his collection; accordingly, having despatched our tent and baggage to Ramouthra, a village thirty-two miles south of Rawul Pindee, we started early on the 21st of March, and rode through an almost barren country, intersected by ravines and water-

* Among the Arctic ferns brought home by me, and reared by Mr Beverly, were found last year several plants of one which he, and several others who examined it, suspected to belong to this species. They were led to this suspicion by observing the form and habit of the fronds, and especially the nature of the rhizome, which spreads more widely, and throws up its small tufts of upright fronds at greater intervals than *C. fragilis*. Just now (June 1862) the plants are in good condition, but the fronds seem not quite so like those of *C. alpina* as they were last year. Though this fern is evidently different from the common forms of *C. fragilis*, and in several respects approaches the so-called *C. tenuis*, in others *C. alpina*, it may perhaps prove to be only an extreme form of *C. fragilis*. But it shall be carefully watched as it grows, in order to fix its identity. At all events, in its present form, if it is not *C. alpina*, it is intermediate between that species and *C. fragilis*, and as worthy of being raised to the rank of a separate species, as many other varieties that have been so treated.

courses, now floundering through a stagnant pool, now cantering on a level space, covered with pebbles, or rough and hard *Kun-kur*. *

This substance is extensively distributed over the Northern Punjab, either as a surface deposit of some thickness, or in heaps along the sides of ravines and river beds. It is usually met with in the form of tufaceous nodules, but not unfrequently in larger masses, from which many of the oldest temples in the country are built. When broken up, and mixed with brickdust and lime, it forms a durable cement; it is also used in road-making.

Long before day-dawn the well-known call of the *Spur-winged-lapwing* (*Lobivanellus goensis*) was heard. This unsettled water-sprite often flies about at night, startling the unwary with its cry of "*Did-dee-doo-it?*" "*Did-did-did-dee doo-it?*" Like the crested-lapwing, or pewit, it assails all who intrude on its haunts.

When morning dawned, we found ourselves on the banks of the Swan, one of several streams which rise at the foot of the Himalayas, and coursing westward empty themselves into the Indus. Many of them are completely dried up in summer, or present only a series of pools and stagnant ponds, with broad pebbly beds. They are very different, however, during the rainy season, when, after a storm, the rush of water is often sudden and furious.

During a terrific thunder-storm, which took place near Rawul Pindee, three soldiers were bathing in one of these pools, close to their barracks, when the flood overwhelmed them so suddenly that they were carried away by its violence. One poor fellow was drowned; and on recovering his body some three days afterwards, it was found to be horribly disfigured by a small species of crab which abounds in these parts.

The fish called the *Masseer* is common in these rivers, and often attains a very large size.

* Professor Ansted is disposed to consider this formation referable to the drift period, and gives the following as its composition:—72 per cent. carbonate of lime, 15 per cent. silica, and 18 per cent. alumina. I have, however, observed a similar deposit in course of formation in the Punjab, chiefly in ravines, and by the sides of streams.

We observed a flock of Cranes (*Ardea grus*, Linn.) in the shallow waters of the Swan. This species migrates to Central Asia in May.

Journeying on we passed little villages surrounded by high walls of mud—clusters of camel-thorn—fields of wheat and barley, with here and there a solitary banyan tree, despoiled by the elephant drivers, who cut down its broad leaves for fodder—now a clump of mulberry or willow trees just budding,—now a ravine or a tract of waste and arid plain,—such are the natural features of this, and great portions of the Northern Punjab.

Among the low brushwood that covers the sides of ravines and hollows, we frequently noticed the Black Sun-Bird, (*Nectarinia mahrattensis*, Lath.); also the lesser brown-coloured Bush-thrush (*Megalurus isabellinus*, Swain.), chirping and chattering in flocks, in a low note, or fluttering from bush to bush with its characteristic feeble and unsteady flight.

The blue Rock Pigeon (*Columba livia*, Briss.) abounds in ravines, and in the fields and hedgerows. The Senegal Dove (*C. senegalensis*) is generally seen either singly or in pairs.

On the side of a steep ravine I killed a fine specimen of the Spotted Eagle (*Aquila naevia*, Gmel.), which is by no means rare in the Punjab. The Black-throated Wheat-ear (*Saxicola atrogularis*, Blyth), is common; its favourite food is a small white worm, which it digs out of the sun-baked soil. Flocks of the Crested Sand-Lark (*Galerida gulgula*, Sykes), were scattered over the desert plains as plentifully as in the southern provinces.

March 22.—It blew strongly during the greater part of the night, and day dawned in the usual Indian style, followed by a brilliant hot day. The first half of our march was very similar to that of the previous day, until we debouched on a vast plain, cultivated here and there. In the distance, running from east to west, the Salt Range was seen, but so far away, that in the hazy atmosphere of mid-day we could do little more than define its outline.

Green Bee-eaters (*Merops viridis*), covered the surrounding country, flitting swallow-like after their winged prey. Num-

bers of a White-rumped Martin* were often seen,—a species common in the north-west during the cold months. The *Sand-Martin*† is also abundant, and builds in the sides of ravines and in the banks of streams. Around the villages (for what Indian village would be complete without them?) were Govind-Kites, Indian Jackdaws, and Mina-birds.

In the fields and sandy wastes were numbers of a *Sand-Lark*,‡ usually gregarious in the cold months, and often seen associating with the crested Sand-Lark first named. This species is larger than the *Anthus agilis* (Sykes), to which it bears a striking resemblance. Its total length is $7\frac{1}{2}$ inches. The markings on the throat and breast are more numerous, with a slight tinge of rufus on the latter; inner surface of the wings dirty white.

March 23.—In order to escape from the heat of mid-day we started very early, and marched the first few miles by moonlight.

The route led by narrow footpaths, through strong ravines and cotton-fields. When day dawned we found ourselves toiling up a rather broad valley, and soon had the mortification of discovering that the guides had lost their way, and our three hours' journey was of no avail; however, we soon got on the right track, and entered on a fine open district, thickly covered with fields of green wheat, and by noon arrived at the town of Chuhkawal, during a Sikh festival, and just as a priest (*Goroo*) was about to address a large assembly in a tent pitched under a noble copse of Peepul, and other trees, where we spent the hottest portion of the day, watching the busy scene.

Pilgrims, fakirs and dirty beggars from all parts of the country were pushing onwards towards the tent, whilst many were bathing in the neighbouring tank. The heat and dust—

* No specimens were procured. I hesitate, therefore, to consider this the *C. urbica*, as Mr Gould found differences in one procured on the Cashmere Mountains sufficient to cause him to name it *C. cashmeriensis*.—*Proc. Zool. Society*, 1858. [We have *C. urbica* from Himalaya, differing from Scotch specimens only in the steel-blue of the upper parts being not so bright.—W. J.]

† *Cotyle riparia*. Several were procured.

‡ Possibly *Anthus desertorum* (Stanley). My specimen did not altogether agree with those procured in Scinde.

the continual hubbub of human voices—the cawing, chattering and chirping of impertinent Jackdaws (*Corvus splendens*), Bulbuls, and Rose-ringed Parroquets, among the branches overhead—rendered our stay anything but agreeable, and made us only too glad when the afternoon came, and we were able to quit the scene.

The Red-vented Bulbul (*Pycnonotus bengalensis*) is generally distributed over the Punjaub. The lesser Yellow species (*P. leucotis*), although not so plentiful, is by no means rare. They are often seen together.

The inhabitants of this part of the Punjaub, known as the *Scind Sagour Doab*, are chiefly Mussulmans. They are a fine, manly-looking race, with long flowing beards and large turbans. The women (such as we were permitted to see) wear capacious peg-tops (!!)—their hair knotted behind; while a loose jacket and a piece of red cloth over the head complete their eccentric costume.

The Pale-chested Harrier (*Circus pallidus*) and Turtle-Dove (*Turtur humilis*) were occasionally seen. The gay Indian Roller (*Coracias indica*) was constantly observed perched on the stump of a decayed tree, or pursuing its corkscrew-like flight through the hazy atmosphere.

The Palm-Squirrel (*Sciurus palmarum*) is common in every grove.

A Fox*, differing, in some respects, from the Bengal Fox (inasmuch as the lower parts, which are white in the latter, are in this species black), was not uncommon in the ravines and around the villages.

The Pied Wagtail (*Motacilla luzoniensis*) is plentiful at this season.

March 24.—We started early, and performed the greater part of the march by moonlight. At daybreak we reached the side of a steep ravine overlooking a most beautiful valley, composed chiefly of reddish marl and grey sandstone, cultivated in several places, and with a large lake of several miles in circumference occupying its centre, on whose placid waters the smoke from the neighbouring villages lay still and defined, as the morning sun shone with brilliancy on the scene.

* To all appearances the *V. pusillus* of Blyth, Jour. As. Soc., 1854, 730.

Flocks of wild fowl covered the surface of the lake, and the pink and white plumage of the Flamingo added much to the beauty of the landscape.

The Wandering Pie (*Pica vagabunda*) was observed. I do not think I have ever seen more than two of these birds together; in habits, it resembles the British Magpie.

The Pied Stonechat (*Saxicola picata*, Blyth) is common.

The Indian Robin (*Thamnobia fulicata*), so general in most parts of Hindustan, is seen here in almost every village and field. Although differing in plumage from its European congener, there is much similarity in their habits; it frisks before the door, and picks up the crumbs, jerking its tail as it hops along! How often have associations of home been brought to mind by seeing this pretty little warbler pursuing its gambols before the door of our Eastern bungalow. Although the song of this species is far from unmusical, it wants the melody of the other.

The Indian Porcupine (*Histrix leucurus*) is found among the low scrub and bush; as an article of food its flesh is much sought after, by Europeans as well as natives.

The Salt Range extends from the Western Himalayas in the east in nearly a straight line to the Suliman Mountains in the west, and is composed of low hills intersected by narrow ravines, or prominent ridges, for the most part devoid of vegetation.

Saliferous sandstone, marl, limestone, red and grey sandstone, would appear to form the chief geological features of the portion of the range visited by us.

The surface, except where extensive denudation had taken place, was covered with scanty soil and rounded pebbles, mostly formed from the breaking up of the limestone strata. Salt is found in various situations, more especially in the neighbouring district, where there are several extensive salt-mines.

The barren and sun-burnt appearance of these mountains strikes the traveller; indeed, it is chiefly that which renders them a safe retreat for the wild sheep, for except in the more fertile situations, these dreary and desolate wastes are seldom disturbed by man.

The *Houriari*,* or wild sheep, extends along the eastern portion of the Salt Mountains, but to the best of my knowledge has not been found to the east or south of the Beas River.

As regards British India, it is confined to the north and western portions of the Punjab, including the Suliman chain, where it is known by the name of *Kuch*. It is also a denizen of the mountains around Peshawar, including the Khyber Pass, Hindoo Coosh, and Kafiristan.

The *Shapoo* of Ladakh, if not identical, is certainly very closely allied; its differences, I opine, are slight, and such as might result from the great diversity of climate and vegetation of the two regions. The "Sha" of Tibet, described by Vigne, has also a close affinity; and possibly the *wild sheep* of Western Afghanistan, Persia, the Caucasus and Armenian Mountains, are likewise of the same species. There is considerable diversity with regard to form and size of horns, in specimens I have examined from the Salt Range and Ladakh, as well as in the build of the animal; for example, the Ladakh sheep were larger, and had the upper surface of the horns rounded, and the tips turned more inwards, whilst the other had the upper surface of the horn flat. However, with reference to other peculiarities, they did not seem to differ in the slightest degree.† The peculiarity in the shape of the horn is certainly striking, and affected all the rams' horns I examined from Ladakh; but too much value must not be put on these distinctions, as every one familiar with horned ruminants in a wild state knows that these appendages are subject to much diversity in individuals of the same species.

The upper parts of the *Houriari* of the Salt Range are fawn colour; the belly and inner sides of the thighs pure white. The male has a black line of rather long hair extending down the dewlap and breast; the horns resemble certain varieties of the domestic animal, but perhaps rise higher and curve more backwards; the horn often measures from 25 to 30

* *Ovis vignesi*, Blyth, Proc. Zool. Soc., 1840, 70.

† My collection of skins and horns is preserved in a little museum in my native village, Banchory-Ternan, Aberdeenshire.

inches over the curvature, and from 8 to 12 inches around its base; that of the female is small, and seldom exceeds 6 inches in length.

On the 25th of March we ascended the side of a steep ravine covered with brushwood, and gained a broad plateau, partly cultivated; there we flushed several covies of Chuckore (*Caccabis chukar*) and Sisi (*Ammoperdix bonhami*, Gray). The former is by no means common on these ranges, or indeed in any part of the Punjaub, although occasionally met with around Attock and Rawul Pindee; its favourite haunts are on the Himalayas, where it extends northwards even to the Altai Mountains. The average weight of an adult male is about $1\frac{1}{2}$ lb. It is found likewise in Persia and Affghanistan. I have seen and examined specimens from all these countries. Mr Vigne in his Travels mentions red-legged partridges in Kurdistan, but does not identify the species with the above.

The *Greek Partridge*, found in south-eastern Europe, specimens of which I obtained in the markets of Constantinople, appears to me identical with *P. chukar* from the Western Himalayas, with which I have compared it. The white throat and fainter rufous colour of the ear-coverts are not invariable distinctions by which the Greek can be distinguished from the other, inasmuch as many Chukore I examined had similar characters.

The Sisi is known to Europeans as the "Bastard chuckore;" it is much smaller than the last. The male measures in the flesh about 10 inches, the female about $9\frac{1}{2}$ inches; the iris is hazel; bill, brownish-yellow, lighter on the legs. Its existence has been known to naturalists for several years, but all the specimens were brought from Affghanistan, where it abounds on sandy wastes and barren mountains. The Sisi is not found in Ladakh or on the ranges to the south and east; and, I think, with the Salt and Suliman Ranges, and probably with the mountains around the Khyber Pass, we define its limits in British India. It is often seen associated with the Chuckore, to which, in habits, it has a close resemblance; the call-note, however, is very different.

The pretty little Red-fronted Fly-catcher (*Muscicapa*

parva, Meyer), is much like the Robin in appearance, and, although less familiar, has many points in common; it affects hedges and dense jungle, and is usually seen solitary. This little creature has a wide Asiatic distribution, and extends westward to southern Europe, even to the south of France.

March 27th.—We pitched our tent close to the little village of Norpoor, and were not settled before its *kotwal* or governor arrived to offer his services in procuring supplies, bringing with him a rupee, which, according to the usual Indian custom, he held out for our acceptance. He appeared, however, somewhat dubious as to our social position, especially our acquaintance with the etiquette which requires that gentlefolks should, on such occasions, merely touch the offered gift, and then make a salaam of satisfaction to the host. As each of us laid our hand on the coin, our Sikh friend squeezed it the firmer, and even closed his fingers over it, then grinned a smile of perfect contentment when he found out that we were persons of consequence—a discovery our shady jungle costume was not calculated to impress. I spent the day among hot marl and sandstone ravines, searching after wild sheep. The reflection was excessive, and we suffered much from want of water, which was only procurable in the shape of red muddy pools in the worn-out basins of water-courses. After much fagging, and several snap shots at wild sheep and ravine deer which we started in the narrow fissures between the marl beds, I espied two of the former lying under the shade of an acacia, and, by dint of much trouble, managed to crawl unobserved within twenty yards, when, forgetful of the old adage, “A bird in the hand is worth two in the bush,” I sought a nearer approach, in order to gain a chance of killing *both*, and, by so doing, had the mortification to lose them, for the ram, catching a glimpse of me, sprang to his feet, and, sending forth his loud whistle, disappeared at once among the tortuous lanes. This mishap was one of many, which eventually taught me never to lose a good opportunity in hopes of obtaining a better, and this advice I can confidently give to all young hunters.

The *Emberiza caniceps* (Gould), Lammergeyer (*Gypætus barbatus*), which doubtless feeds sumptuously at this season

on the young Houriar, and the "Blue Water Thrush" (*Myiophonus Temminckii*, Vig.), hitherto observed only on the Himalayas, were now occasionally seen. The Raven is common. The Crow (*Corvus culminatus*, Sykes) was not seen on the Salt Range or about Rawul Pindee, where, however, the Rook is plentiful during the cold months. Now and then the Pied Woodpecker (*P. himalayanus*, Jard.) was observed on the acacia and other trees.

Hares (*Lepus nigricollis*) were killed occasionally. I obtained a specimen of a short-tailed field mouse. Wild pigs are very plentiful and exceedingly destructive, but seldom seen, as their depredations are made at night, and they secrete themselves in the most secluded and impervious jungle during the day.

We pitched our tent in the most retired spot we could discover, distant from the habitations of man, and in the centre of the Salt district, where the Houriar repair at dusk to lick the salt-encrusted rocks. The streams and wells of the neighbourhood were all more or less tainted with that substance; fresh water was therefore very scarce.

During our day's ramble, and when clambering across a rough mountain ridge, I suddenly encountered a brawny Sikh; he was minus his nose and right hand, which he said were cut off by order of Runjit Sing as a punishment for murder, he having at the age of eighteen killed his brother. When told that now-a-days his life would be forfeited by such a crime, he replied, "Yes, sir," most unconcernedly; and, with a sly shrug of his shoulders, my friend turned and moved down the ravine (I fancy to pursue his habit of salt stealing), whilst I pushed upwards, and gaining the summit of the mountain, had a magnificent view of the Indus, tracing its winding course for upwards of thirty miles through the hazy atmosphere of the plains. The heat of the sun and the reflection from the sides of the red ravines were very powerful.

Of wild sheep we saw many, but the cover was scanty, and they were always on the alert. If a herd was feeding in a ravine, an old ram was seen to be on the outlook on some near eminence, and as soon as he apprehended danger, he

sent forth a loud whistle, and the whole herd took to flight. There are few ruminants in which the senses of sight and smell are more highly developed than in the Houriar, although natives allege that the latter sense is either very feeble or wanting altogether.

By European sportsmen this animal is frequently called the "deer-sheep," and viewed abstractly, it is certainly a strange-looking admixture of the two—the horns, gait and bleat, are decidedly ovine; it has the infra-orbital apertures of the deer, together with the gracefully formed limbs and fleetness of that animal. The hair is thick, and though not long or curling, is in texture quite different from that of the deer.

In barren stony places, among the ravines, we often saw a Redstart,*—the Bay-backed Shrike (*Lanius hardwickii*, Vigors) was plentiful in bushy places, and on the acacias.

The Black Sun-Bird was beginning to pair, and the soft note of the male sounded sweetly from the surrounding bushes. Its song resembles that of the chaffinch, but is more melodious.

All over this country, in secluded valleys, on hill-sides, and out of the way places, graves were of frequent occurrence; some had an erect pillar at either end, marking the head and feet, while many have an intermediate one. I was told the latter distinction denoted the grave of a female.

We noticed more of the ancient buildings before named—they are chiefly in ruins. One quadrangular-shaped building, composed of large blocks of limestone, was observed near the village of Jubba; narrow archways, opening into separate compartments, were on each side of the square. The generality of these buildings are flat-roofed, and seldom more than from four to five feet in height, surrounded by trees and accumulations of rubbish.

A native sportsman assured us that tigers, leopards, hyenas, wolves and antelopes,† besides an occasional black bear‡ from

* No specimens were procured; but I believe the species to have been *R. ticilla phanicura* from the white on the forehead. *R. indica* I have not recorded in my notes of the Punjab, and am inclined to think I have overlooked that species, which is said to be common in North-Western India.

† *Cervicapra bennoarctica*—the Black Buck of Indian hunters.

‡ *Helarctos tibetanus*, Cuv. *H. malayanus* is not found in the Punjab.

the Himalayas, jackals, foxes, &c., are met with on the Salt Range.

March 30th.—Although the scenery of these mountains is generally devoid of beauty, one comes occasionally on little spots by no means wanting in natural attractions.

This morning we rose at daybreak, and after an hour's toil across a very stony plain, covered with briars and thorns, we arrived at the brink of a broad ravine, the sides of which were covered with dense and luxuriant vegetation.

The peepul, camel-thorn, mulberry, and wild fig, formed small shady groves in which the Fakirs had built beautiful little temples, surrounded by gardens in flats, like steps. Patches of wheat, tobacco, and the red and white opium-poppy, grew in these.

On a prominence jutting into the ravine, stood a shrine, which at a distance looked like a miniature castle; and far down, among tangled briars and bushes, rolled a clear stream.

Flocks of pea-fowl, preserved by the religious devotees, were seen in all their native elegance and beauty, their wild cries resounded through the glen, as now and then one darted past us, his gorgeous shades of plumage refulgent in the morning sun. It was an enchanting scene, but as the heat was increasing every moment we hurried onwards, and soon gained the opposite plain, where we discovered a herd of Houriar, headed by two great rams; the nature of the ground, however, prevented a nearer approach than 300 yards, from which distance I fired on the largest male and broke his hind leg, but unfortunately the poor animal escaped after I had followed his bloody trail for several hours under a burning sun. When once scared, it is seldom the Houriar rests for the remainder of that day, but, keeping on the alert, moves along the most commanding ridges. If caught young, the animal is easily domesticated. I have seen an adult female become so tame as to feed with a herd of goats, and regularly attend at the kitchen for food. I believe, however, the rams are very unmanageable and pugnacious; they fight in the same way as the tame species, and their *bleat* is similar.

When driving a jungle in search of wild pigs, I observed a specimen of the Great Wild Cat or Chaus (*Felis (lynx) chaus*,

Guldenst.). It is pretty common in the Punjaub, and hunts among the ravines and broken-up country. In a hollow, more or less covered with scrubby jungle, we were suddenly startled by observing large blood-stains, and in one spot decided traces of a struggle with the foot-prints of what must have been either a leopard or a tiger, more likely the latter, as the villagers informed us that their cattle, sheep, and goats were often carried away by tigers—and on the present occasion a young bullock was missing. It is difficult, however, to be certain as to the depredations of one or the other, as they are chiefly committed at night. The Leopard (*Leopardus varius*, Gray; *F. pardus*, Linn.), seldom attacks cattle, and chiefly confines itself to the smaller deer, tame sheep, goats, or dogs—the latter it has been known to carry away at night from the centre of a village.

The Black Partridge (*Francolinus vulgaris*, Steph.), is not generally distributed in these parts, the country not being sufficiently cultivated and inviting; moreover, I do not think the Chuckore and this species ever frequent the same cover, although the former and the gray partridge are often found together.

Flocks of the Wood Pigeon (*Columba palumbus*) were common in the fields. All the Indian specimens I have examined had the neck patch clay coloured; but in other respects there does not appear any difference between the European and Eastern bird.

April 2.—A hail storm took place during the day, and lasted for upwards of twenty minutes; many of the hailstones were as big as sparrows' eggs. The palæontology of these ranges must be very interesting, but my time was too much occupied with the object of our excursion to allow me leisure to examine the geological formations with care. I wandered over a rugged hill-side above this village, picking up fossils at almost every step, chiefly bivalve and large spiral univalve shells and species of galerites, and other echinoderms, until attracted by a large lake which was covered with flocks of flamingoes—their tall, gaunt forms looking like balls of pink and white suspended in the shallow waters. As usual, with this species when roosting, each bird had its head under its wing,

and was supported on one leg, with the other drawn up. I am afraid I rudely disturbed their slumbers, for, resting my rifle on the wall of a house overlooking the lake, I sent a leaden messenger into the densest part of the flock, and when the frightened host had fled, one was seen to drop and float into the deep water. The average length of the flamingo (*Phoenicopterus roseus*, Pallas) from the bill to the extremity of the middle toe, is 5 feet 7½ inches, and between the tips of the wings 5 feet 10 inches; weight 5 lbs. These measurements are the result of many trials. The genital organs of two shot at the latter end of March were very small. I have found this the case with several migratory species, especially those which breed on the lakes of Tartary, such as the White-fronted Goose, Ruddy Sheldrake, &c. The flamingo is certainly migratory in Northern India, and most probably breeds on the lakes of Central Asia, where I have gathered the eggs of ducks and geese as late as the end of July. There is considerable variety both as to size and the colour of plumage, irrespective of age and sex. Mr Jerdan mentions a small race appearing in separate flocks.* All I have seen on the rivers of Northern India were of the larger variety, with long legs. In a flock many may be seen with dark-coloured backs and pink under the wings, with the rest of the plumage pure white—these may possibly be young or immature birds; others with a delicate pink all over, the intensity keeping pace with age. Coots (*Fulica atra*) were common on this swamp. Behind the village of Kotila arises a steep mountain, probably the highest on the range; its top only is covered with long grass and a few fir trees (*Pinus longifolia*). I looked in vain on the highest hill tops in the neighbourhood for any botanical productions similar to this little isolated patch, which was clearly owing to the greater altitude of the Kotila mountain top; these few plants and a tree only to be seen at certain elevations on the Himalayas, were detached like an oasis on the top of this barren mountain.

In many situations whole fields of grain are laid waste by wild pigs; we observed their depredations in the wheat fields, and the ground covered with their masticated pellets, com-

* Madras Journal, vol. xii. p. 217.

posed entirely of the tops of grain. The hills around Kotila and Sookeysair are too much frequented by tame goats and sheep to afford day retreats for the Houriar, which is seldom found in the open country except at night or in the early morning; their favourite resting-places during the day are among the wild, dreary, and desolate ravines, where "hunter's horn was never heard, or hum of forest bee." Wild pigs secrete themselves in the dense jungles during the day, and repair to the cultivated tracts at dusk, returning again at break of day, in spite of the exertions of the farmers to frighten them away by loud noises. Perhaps like the black bear of the Himalayas, they soon get accustomed to sounds, and care little for anything of the sort unless in their immediate vicinity.

The Ravine or Bennett's Deer (*Gazella Bennetti*, Sykes), better known to English sportsmen as the "Chinkara," is pretty plentiful among the low hills of the Northern Punjab, especially on the Salt Mountains; it does not, however, affect any portion of the Western Himalayan range. The horns of the male seldom exceed 18 inches; those of the female are smooth, and usually 4 inches in length. The ravine deer is usually seen solitary, but occasionally small herds may be observed. The cerumen or wax from the infra-orbital sinuses of a male killed by me on this occasion was rubbed on the horns, and produced a polished appearance, which, even in the dead animal, lasted for several weeks. As I have often seen this species, the Cashmere stag, and other animals, with the above mentioned appendages, rubbing their foreheads and horns on trees, I have supposed they might be pressing out the wax, the use of which may be to prevent the horn decaying. When we consider the apparent smallness of the little bag on the rump of an eagle, and the number of feathers which its contents are supposed to lubricate, we need not be surprised at this disproportion between the contents of the sinuses of the moose or red deer with the great surface of horn they may be imagined to preserve from decay.

April 6.—The ravines around Jubba have a peculiar appearance; viewed from a height, they present a series of worn and denuded angular hillocks, intersected by nar-

row defiles, by no means inviting to the traveller. Not a blade of grass is visible, and the red marl suggests the idea of sleeping volcanic embers, more especially during the heat of mid-day. I have scarcely ever witnessed a scene so perfect in its desolation; however, we determined to descend, in spite of the excessive heat, and reflection from the marl and sandstone. While threading our way among these hillocks, we came on a young Houriar just born, and evidently abandoned by its mother. On seeing us approach, several herds of rams were observed dashing across the ravines, and I had a snap shot occasionally. By noon, as we had anticipated, the heat became excessive, and thirst intolerable; no water could be procured save what was strongly impregnated with salt. At last, exhausted, I gave in, and must have been verging on a *coup de soleil*, as my senses began to leave me, and I felt my eyesight and hearing rapidly failing, accompanied by loud sounds in the ears. In this condition I lay stretched on the shelf of a rock, whilst the Shickaree* set off in search of a spring of fresh water. Soon afterwards the voice of a native roused me from my helpless stupor, and I gazed on a half-naked man carrying a basin of milk and platter of cakes, which he begged I would accept. "The good Samaritan," a Mussulman, had seen my distress from his dreary watch tower on the top of a neighbouring hill, where he resided for the purpose of guarding a vein of salt. Never shall I forget the kindness of the poor fellow, who, unsolicited, came to my aid at a time his services were so sorely needed. Whilst in the neighbourhood of Jubba, we were visited by a young Englishman, employed in the Salt Revenue Department. He appeared a regular Robinson Crusoe, having spent many years among those horrid hot ravines, without any companions save his native followers. He said that during the hot months he was obliged to turn day into night, in consequence of the heat, as it was certain death to visit his various posts in the day time. He was an example of (what may be often seen in India), an Englishman born and brought up in that country without the shadow of an idea of anything beyond Hindustan and its European society, and

* Native sportsman.

even the smallest portion of thought on the latter; for his manners were more in common with the natives, whose language he spoke more fluently than his own. The poor fellow was somewhat concerned about his health, in consequence of a fever which had twice nearly finished him, and looked forward with dread to the approaching summer, indulging, however, in a hope that he might get another district where he would at least have the advantage of a better house to cover him. And judging from his wan and pale face, there seemed just cause for his anxiety.

My friend, during a hunting ramble, found three young Houriards, and had the good fortune to kill two old ones. Our little herd—now increased to two males and two females—took kindly to the tame goats, and became as much attached to their foster-mothers as they would have been to their parents. The goats also got reconciled to them, except one old dame, that positively refused to suckle her foundling, and required to be held during the process. It was pleasing to see the lambkins frisking about the goats, and rushing towards them for protection, bleating whenever they got separated. For several days all seemed to thrive, when they began to pine and die, one after another, with a discharge from their noses, and a cough, which I discovered afterwards arose from inflammation of the lungs, portions of which were very much congested, and here and there consolidated (to use a medical expression, hepatized).

The Blue Rock Thrush (*Petrocincla cyanea*) is not a rare tenant of rocky situations and bleak hillsides. All I have examined in the Punjaub and lower ranges of the Western Himalayas were of the short-billed variety; the other (*P. longirostris**), I obtained only in Ladakh and Tibet. This thrush is a wild and wary bird. The Black-breasted Sand Grouse (*Pterocles arenarius*), or Rock Partridge, as it is better known to sportsmen, repairs in flocks at daybreak and dusk to drink at tanks and ponds.

Both the Moor Buzzard (*Circus æruginosus*) and Pale-chested Harrier were common, and usually seen hovering over the wheat-fields for mice, lizards, or quails. I have

* Blyth. See Jour. As. Soc. vol. xvi. p. 150.

seen them pick up and carry off quails immediately after being shot.

The Daurian Swallow (*Hirundo daurica*) was plentiful in and about the ravines. I procured a specimen of the Roseate Finch (*Carpodacus erythrinus*, Pallas) from a flock which was feeding on the blossoms of a mulberry tree. Numbers of the Malabar Grosbeak (*Munia malabarica*) frequented the hedges. Its sweet plaintive twitter is very pleasing. This little creature is so tame that you may approach it within a few yards. They are easily caught with nets, and in much request as cage-birds.

April 12.—Arrived at the Kuller Kahar Lake, although many of the avi-fauna of this lake had taken their departure for the cooler regions of Tartary to breed, still many interesting species remained, and afforded us ample occupation in shooting and preparing specimens. It would appear that in many migratory birds the aphrodisiacal tendency is not always incited by spring. For instance, the genital organs of two males of *Casarca rutila*, and several Flamingoes, examined on this occasion, showed no symptoms of enlarging, whilst in the Shoveller Duck and several of the other migratory species these organs were observed to be rapidly increasing in size. This agreed with my previous experience on the Ladakh lakes, where I found the first with eggs and young just hatched as late as the end of July, whilst shovellers, teal, mallard, &c., had long since left the marshes, and were assembled on the lakes with their broods fully fledged. It is probable, therefore, that as long as the sexual organs remain small the longer will the birds remain in their winter quarters, for it is evident that the development of these organs takes place before the bird commences its migration; as, on the other hand, want of food and climate send it back again in autumn. It is apparent, however, that birds often over-reckon distance, and exceed the bounds of their usual sojournings, as numerous examples in the avi-fauna of Europe show. Many are driven from their haunts by stress of weather. Thus, although birds are wonderfully unerring in their judgment of distances, they are not always exact. How often have carrier-pigeons been lost?

For several days previous to our arrival at Kuller Kahar Lake the weather had been unusually hot, and the day haze denser than I had ever seen it. There is no difficulty in accounting for this phenomenon in many localities where exhalations from the soil are present; but when observed, as it often is, in the desert, and in dry parched places, we cannot so easily attribute its presence to the same causes. Possibly some unexplained electric or other condition of the atmosphere also enters into its composition. I have seen it up to 6000 or 7000 feet on the Himalaya, but not in the rainless region of Ladakh or Tibet. A thunderstorm seems to disperse the fog, and renders the atmosphere particularly clear for days afterwards, even during a fierce sun. On the night of our arrival at Kuller Kahar we were awoken by a furious storm which nearly blew our little tent down; the roar of the thunder and the brilliancy of the lightning were perfectly appalling, whilst the rain fell in torrents; the whole did not last above an hour, and left behind the usual delightful and exhilarating weather which comes so grateful to man and beast after days or weeks of feverish heat. I will never forget the enchanting little scene and bright sunny morning following, as groups of red and white flamingoes in long lines stretched along the shallows of the lake, and ducks and other aquatic birds lined the margins, or crowded in dense flocks in the deeper parts, whilst from the jungle-clad hill on the right loud wailings of peafowl kept by the fakirs of the temple on its summit resounded across the valley, and the green bee eaters, black Drongo shrikes (*Dicrurus longicaudatus*) and others hunted around the copse in which we were encamped, pursuing the countless myriads of insects that appear on these occasions, especially the white ant, which affords great diversion to these birds. We found flocks of long-legged Plovers (*Himantopus candidus*) on the lake. This species is common in the pools of the Northern Punjab during the winter months; specimens are often met with having their legs bent and deformed.

The Cinereous Godwit (*Limosa ægocephala*), Green Sandpiper (*Totanus ochropus*), and Water Rail,* are generally distributed over the lakes and fens. The Lark Toed and Pied

* *Rallus aquaticus* of Indian authors. *R. indicus* (Blyth), Jour. As. Soc. xviii.

Wagtails are plentiful. The Ruddy Goose (*A. rutila*) was often observed. The Castaneous Duck (*A. nyroca*) was seen in flocks. We bagged also a few jack and common snipe.

The *Vanellus leucurus* I did not observe elsewhere; it is certainly rare in most parts of India. The bill is black, irides hazel, margins of eyelids red, legs yellow. This Lapping is probably migratory in the Punjaub. I was told that it is common in Afghanistan, where it is known by the name of "Chiric." In habits it closely resembles sandpipers, frequenting margins of lakes and wet situations; it runs at great speed.

Besides the Long-tailed Swallow (*Hirundo filifera*), I procured a small Sand Martin, which I mistook at first for the common Bank Swallow (*C. riparia*). It is different, likewise from the *C. brevicaudata*,* with which it was compared by Sir William Jardine, who informs me that if not a small or local variety of one or other of the above, or *C. subsoccata*† of Mr Hodgson, it is a new species. The total length in the flesh four inches. Upper parts greyish-umber. Wings darker; length $3\frac{1}{8}$ inches, as long as the tail. Tail moderate and nearly even. Throat dirty white. An irregular band of greyish umber across the breast. Belly, vent, and under tail-coverts, white. Tarsus almost naked, except the minute tuft above the insertion of the hind toe. To the above we added the Shoveler (*A. clypeata*), Red-crested Pochard (*A. rufina*), Garganey Teal (*A. querquedula*), Red, and Green-shanks (*Totanus calidris* and *glottis*), Little Grebe (*Podiceps minor*), and Temmincks Sandpiper (*Tringa Temminckii*).

We returned to Rawul Pindee by a somewhat different route, more to the north and east of that by which we came. Thunderstorms were of daily occurrence for upwards of a week, and always followed by fine cool and brilliant weather, when we enjoyed magnificent views of the great Himalayan chain from the Benibur Pass to Attock on the Indus. The last ten days of our journey, however, were very hot, the thermometer standing as high as 92° in our tent, and 115° a foot from the ground outside the tent. Near the village of Bone, on the northern skirts of the Salt Range, we came on a party em-

* Proc. Zool. Society, 1839. 156.

† Cat. Brit. Mus., No. 332.

ployed sifting the soil for gold, which is found in minute particles among the dark-coloured earth on the sides of hillocks and in dried up water-courses. Native boys were employed pouring water on the earth, which after percolating through a perforated box, was removed and carefully examined. They assured us what of the precious metal they found was scarcely enough to repay the labour.

On the rugged footpaths among the ravines were round cairns of stones similar to the "*chaitis*" seen in Ladakh; and solitary graves of travellers, murdered during the Sikh dynasty, were often observed on the road sides, and surrounded by heaps of stones, rags of various colours, pieces of wood, cotton, &c., the donations of passers by, who invariably leave some token of respect, and more from that than anything else, we got into the habit of doing the same. Moreover, it reminded my companion and myself of the ancient habit of "adding a stone to the cairn once so prevalent on the bleak hill sides of old Scotland." What Scotsmen are not tenacious of their ancient customs?

April 18.—The mulberry was ripe, and the trees laden with this delicious fruit, which in flavour equals that of Cashmere.

Our route for some days led through fields of grain then fast ripening, or across ravines, and streams swollen by the late rains, which had furrowed the country with deep chasms, and borne vast quantities of alluvium to the greater rivers, to be in turn conveyed to the mighty Indus.

The Persian lilac (*Falso sicomoro*) was in full bloom, and an abundant spring harvest approaching. Everything promised well for the industrious people who had settled down to our rule; and, if they would only confess, are far more comfortable and safe than when under the oppressive sovereignty of the native rulers. The village boys were employed in the wheat fields frightening away thousands of Brown-headed Buntings (*Euspiza icterica*) and Rose-coloured Pastors (*Pastor roseus*), flocks of which were seen scouring across the country, and weighing down the ears of the grain as if it had been laid by the wind. The former is only seen in the Northern Punjab during the harvest months, and may possibly

come from the west; it is said to be common about Candahar,* from April to the autumn months. The other species is generally distributed and indigenous in the Punjaub. There is a lizard about a foot in length—blunt-nosed, tail obtuse, body covered with large and broad scales—plentifully distributed over the wastes, where it forms burrows, and may be seen basking in the sun at their entrances.

The Blue-throated Warbler (*Cyanecula suecica*) was occasionally observed, and as usual, with the spot on the breast rufous.

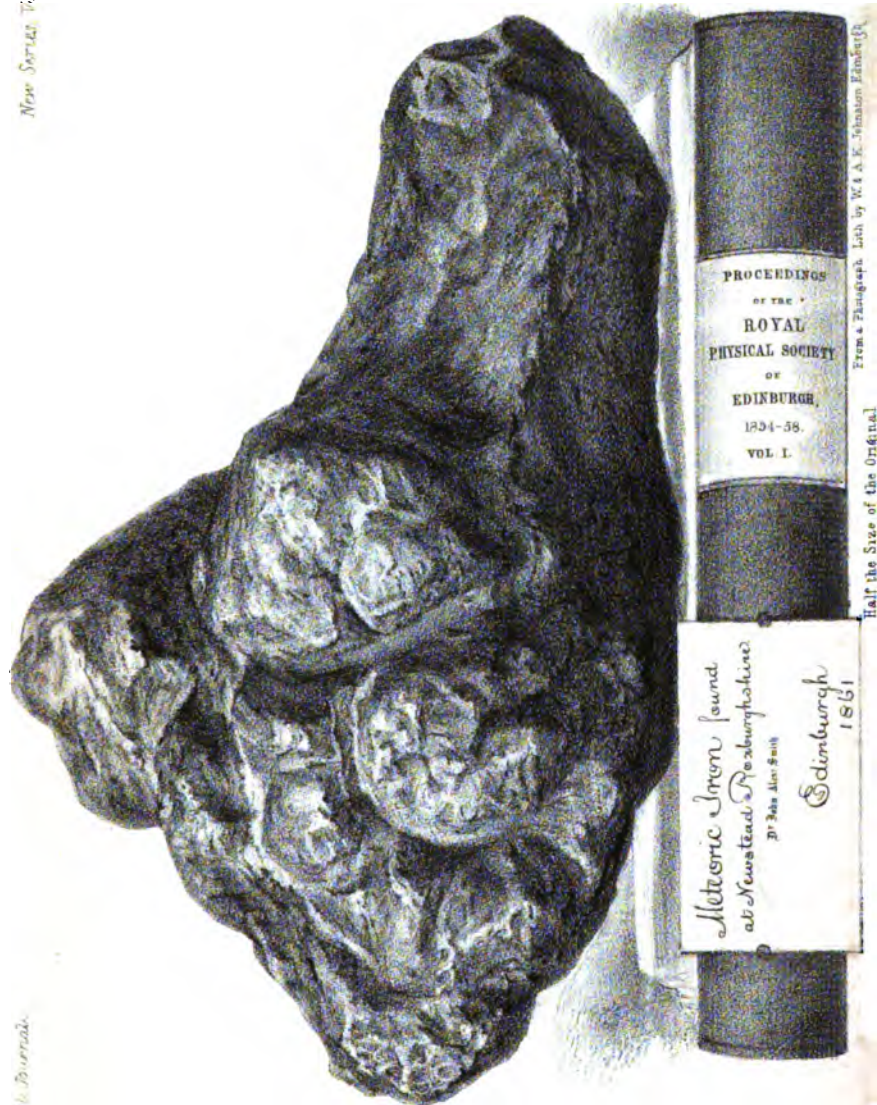
The Black-bellied Larkfinch (*Pyrrhylda grisea*) is a common denizen of arid and barren plains, and squats close on the ground. Herons (*Ardea cinerea*) were hunting in the shallow pools, and the Gull-billed Tern (*Sterna anglica*) was observed flying wildly northwards in scattered flocks, and not settling anywhere, evidently on their way to the cooler regions of Central Asia. We also hurried on towards our homes, for the hot blasts from the west told of the approaching summer, and showed we could not much longer roam over these plains at mid-day. Within ten miles of Rawul Pindie, we found our horses waiting us, and mounting, scampered across the country, sorry indeed to return to the dismal monotony of a small cantonment life. My companion, "a huntsman keen," grumbled at his indifferent luck in not having procured more game; for my own part I had no cause to be dissatisfied, having combined much healthy recreation with intellectual improvement.

Notice of a Mass of Meteoric Iron, found in the Village of Newstead, Roxburghshire; with some General Remarks on Meteorites. By JOHN ALEXANDER SMITH, M.D.† (Plate II.)

Description of Mass of Iron.—The external surface of this mass of iron (exhibited to the meeting) is rough and irregular; and it affects the magnetic needle very strongly.

* See Catalogue of Birds in the East India Company's Museum, vol. xi. p. 487.

† Read before the Royal Physical Society of Edinburgh, April 23, 1862.



Meteoric Iron found
at Newstead Rosburghshire
Dr Robt Allan Smith
Edinburgh
1831

PROCEEDINGS
OF THE
ROYAL
PHYSICAL SOCIETY
OF
EDINBURGH
1834-38.
VOL. I.

From a Photograph. Lith by W & A K. Johnston Edinburgh
Half the Size of the Original



Its shape and general appearance is rather elegant, consisting principally of a large rounded and lobulated mass, irregular in outline, which tapers rapidly at one end to a four-sided pyramidal extremity, and terminates in an obliquely truncated point. (See Plate.)

For the purpose of a detailed description of its form, it may be divided into two portions: the larger extremity, which is rounded in its character; and the smaller, flattened, and smoother on its surface, which tapers to a blunt point. The first, or larger portion, is formed of a clustering mass of rounded lobes irregularly grouped together, and terminates behind in a broad blunt edge. The lobes vary in size, and in their greater or less projection from its surface. A deep furrow runs obliquely round the whole mass, and in front of it (towards the pointed extremity) there rises a large, round, and prominent lobe, with a smaller lobe on one side, and two, more irregularly shaped, projecting masses on the other; by measuring round these masses you get its greatest circumference. The second, or smaller portion of the meteorite, lies immediately in front of the prominent lobes just described, its rounded outlines rapidly changing into four irregular smoother surfaces or planes, which, meeting one another with two acute and two obtuse angles, together form a somewhat pyramidal four-sided figure, which tapers rapidly towards this end of the mass, and terminates in an irregular quadrilateral or lozenge-shaped extremity. The sides of this lozenge measure each about $2\frac{1}{2}$ inches in length; and one of these sides (showing a dimpled outline), from the oblique position of this lozenge-shaped extremity to the general mass of the meteorite, forms its small terminal edge, or pointed extremity.

The whole shape of this piece of meteoric iron suggests the idea, that when its fall took place, the extremity, now the smaller and more pointed, first reached the earth, which, from its resistance, crushed the glowing and softened mass into these peculiarly flattened surfaces of its pyramidal extremity, bending even the oblique point itself, a little upwards and backwards; while the larger extremity, though slightly flattened below, where it struck the ground, still shows in the projecting masses of its upper surface, the part least affected

by the shock of its terrible descent through our atmosphere, to bury itself in *terra firma*.

Size.—The mass of iron measures $11\frac{1}{2}$ inches in its greatest length, and 7 inches across the widest part, about the middle of its length; the larger blunt-edged extremity measuring $5\frac{1}{4}$ inches across. Its circumference round the larger extremity is 1 foot 7 inches; round the large lobular projection (about the middle of the mass) its widest part, 1 foot $9\frac{1}{2}$ inches; while within $1\frac{1}{2}$ inch of the point, it measures only $9\frac{1}{2}$ inches in circumference.

Weight.—It weighed 32 lbs. 11 ounces $1\frac{1}{2}$ drachms, avoirdupois, equal to 39·60 lbs. troy.

Specific Gravity.—The specific gravity of the entire mass, Dr Murray Thomson informs me, is 6·517.

Colour.—The external surface of this meteoric iron is of a dark reddish brown, approaching in some parts to black; and the lobulated parts show here and there, especially in the furrows which divide them, spots of a brighter red colour, due apparently to the partial oxidation of its surface.

Photographs.—The general appearance of the meteorite is well shown in the photographs exhibited. These have been beautifully taken by Mr Alexander Mc'Coll. The mass of metal was laid on the 8vo vol. of the Royal Physical Society's Proceedings, which thus gives a correct idea of its relative size and proportions; and, when the second picture was taken, the volume was turned quite round, without touching the iron; and in this way an exact representation of both its sides was obtained. From one of these photographs the accompanying Plate of the meteorite is taken.

Plaster Casts.—For the purpose of preserving completely the original appearance of the meteorite, a mould was carefully taken before it was sent to the lapidary to be cut. This has been very successfully done, as shown by the casts* exhibited, coloured after the original.

Rarity.—This mass of meteoric iron is the largest that has yet been discovered in Great Britain; only *one* other

* Mr Alexander Stewart, 1 Surgeon Square, will be glad to supply casts, at a very moderate price, to any one who may wish to possess an exact *fac simile* of this rare specimen of a Scottish meteoric iron.

indeed, is known, a very small one—about the size of a hazel-nut. Robert Philips Greg, Esq., of Manchester, in his recently published valuable work,* and in letters with which he has favoured me, states that this small mass of meteoric iron “was found a good many years back by Da Costa, at Leadhills, and is now in Mr Greg’s collection.” It has since been secured for the national collection, the British Museum. Mr Greg tells us the proportion of meteoric stone to iron-falls may be taken at 25 to 1,—i. e., 96 per cent. of all that fall consist of stony matter; and in his *Mineralogy* he gives a list of nineteen or twenty meteoric stones, the fall of which has been recorded, as occurring in Great Britain and Ireland. The instance above referred to is, however, the only one of meteoric iron previously known and recorded. In the neighbouring country of France one specimen has been observed; and Mr Greg gives twenty-seven instances of meteoric irons found in the old world.

History of the Discovery of the Meteoric Iron.—The ancient village of Newstead, where this mass of iron was found many years ago, lies at the eastern extremity of the valley of Melrose, its cottages rising gradually up the bank, towards the higher ground beyond, which was probably the site, as I have formerly pointed out, of the Roman town of Trimontium.† Having already referred to this neighbourhood when various relics of the Roman occupation, discovered here, were presented to the Museum of the Society of Antiquaries of Scotland, I shall now simply point out the exact locality where this mass of meteoric iron was discovered. Like other Scottish villages which have not been interfered with in their formation by the over-ruling taste of some adjoining great landowner, the dwellings of the little proprietors or feuars have been scattered over the ground as their own fancy or convenience dictated, —keeping, however, in a general way by the lines of the roads which intersect the village, and clustering especially along the principal highway which passes through, running east and west, from Drygrange Bridge

* *A Manual of the Mineralogy of Great Britain and Ireland.* By R. P. Greg and W. G. Letsom. London, 1858.

† See *Trans.*, vol. iv., and *Proc. Soc. Ant. Scot.* vol. i. &c.

towards Melrose. On the south side of this last mentioned road, and near the eastern termination of the village, there is a group of three cottages, beyond which a narrow cross road turns southwards into the valley behind, past one of the village wells, and crosses the little streamlet which runs at the bottom of the cottage gardens.

In the year 1827, Mrs Kate Williamson or Davidson, the proprietor of the third cottage from the cross road just referred to, commenced to build another small cottage along the western border of her garden, to which there was access past the open end of her house, forming as it did the farthest west of the little group of cottages. The house was to be erected behind the other cottages and at right angles to them, and, to save the garden ground as much as possible, it was to be placed along its boundary. The garden was enclosed by a broad mound of earth or old turf wall with some stones intermixed; this, of course, had to be removed, and the ground brought somewhat to a level surface before the foundations of the house could be dug; these were then cut out of the firm undisturbed clay below, and the building operations commenced. Mrs Davidson had her own peculiar ideas of what were to be the special conveniences of her new cottage, and, accordingly, she caused two small pits or cellars to be dug in the floor of the kitchen, at no great distance from the back wall and fireplace, which were to be covered over with wooden lids or doors, and in them coals or other necessary articles were intended to be kept. Curious enough, it was in the process of digging out one of these sunken cellars that the black extremity of this piece of meteoric iron was noticed sticking in the clay, at a depth of some three or four feet from the floor of the house. These pits were dug out of the ground, close by the boundary of the garden, on that part of it formerly covered by the broad mound of earth, or old turf wall, which formed the original fence. (The site of this house is well seen in the Ordnance Survey Map of the village, in the small division No. 2211.)

The unusual appearance and great weight of the black-looking stone attracted the attention of Mr George Burnet, one of the masons employed at the work; and as he had a taste for

collecting anything peculiar, he carried it to his own cottage, which was only a few doors farther down the village. Mr George Burnet died in 1842, and Francis his brother succeeded to the cottage and garden, which he still occupies. Some time after a stone wall was built round this cottage garden, and as specimens of different kinds had been collected, an old stone trough, which happened to be in the way, was laid on its side and built into the wall, forming thus a sunk recess, where those various specimens which were considered scarcely ornamental enough to be kept in the dwelling house, could be placed in safety; and here this mass of meteoric iron has lain, for five-and-thirty years; exhibited from time to time, with the other curiosities, to any chance visitor whose fancy might lead him to examine them.

Francis Burnet is an intelligent, observing man, and to him I was formerly indebted for collecting some of the Roman relics which were found in the neighbouring fields. When residing in the district last summer, I visited the village, to learn if anything new, or rather old, had been observed in the course of the agricultural operations of the last few years; and my attention was soon attracted to the small collection of specimens in Mr Burnet's garden. I was at once struck with the very peculiar appearance of this mass of metal, which we removed to the burn side at the foot of the garden, to get washed and inspected more carefully. I then learned the history of its discovery, already so minutely detailed, and afterwards inspected the locality itself, being anxious to collect and put on record all the incidents relating to this specimen, which I was inclined to think might turn out to be a mass of Meteoric Iron. A hammer was got, and one of its corners was slightly abraded; this showed the pure metal of which it seemed to be composed; and its great weight, as compared with its size, proved that it must consist almost entirely of metal, it was therefore no ore of iron. While its peculiar shape was totally unlike that of any kind of manufactured metal—for its hardness, and closeness of grain, suggested that it resembled hammered iron, or steel; the district however, was no iron-producing one, and forges of greater size than that of the village blacksmith were quite unknown, and its history

pointed to a period probably long before historic times. I was therefore convinced the specimen was native iron; and from the very great rarity of this metal in any quantity, and the fact of its being found buried in the clay bank, there appeared to be little doubt it was of meteoric origin. Stating my conclusions to Mr Burnet, and my anxiety to get possession of the iron for a more careful and decisive examination, he kindly agreed to let me have it for this purpose. Accordingly, it was arranged it should be immediately forwarded to my residence, that I might take it with me on my return to Edinburgh, for a complete determination of its true character and peculiarities. On mentioning to Mr Burnet my astonishment that no person had ever called attention to this very singular-looking piece of metal, the true character of which had been so long overlooked, I was informed that, some three or four years before, the Rev. Dr Rogers of Stirling, when on a visit to Newstead in search of Roman remains, among other things had examined it, and seemed to take a somewhat similar view to mine of its origin; but nothing having been said or done to settle the apparently very doubtful question, Mr Burnet had thought no more about the matter.

On bringing the mass to Edinburgh, it was shown to various friends, who at once agreed with me there was little doubt of its meteoric character. With Mr Alexander Bryson and Dr M'Bain's kind assistance, an abrasion was made on its surface, and the nitric acid test applied, when a slight appearance of the peculiar and characteristic etching became manifest; a little of the metal was then filed off, and put into the hands of Dr Murray Thomson, lecturer on Chemistry, without letting him know its history, and he informed me the filings consisted of iron, with a proportion of nickel. Native iron of terrestrial origin being almost chemically pure, and never containing any proportion of nickel, the mass of iron was therefore of meteoric origin, being an alloy of iron and nickel; the latter generally existing in very small proportion to the former.

The peculiar shape and appearance of this mass of metal itself, so entirely unlike any handiwork of man, was indeed almost proof enough to many of its meteoric character, of which, however, there was now no room for doubt.

The subsequent steps taken to learn the special peculiarities of its structure and chemical analysis have now to be detailed.

Section of Meteoric Iron.—The iron was cut longitudinally into two portions, by Mr Young, lapidary, as I was anxious to see whether any difference of structure existed in any part of the mass, or whether cavities containing olivine could be detected. Nothing of this kind, however, was disclosed, the mass being equally solid, dense, and steel-like in its appearance throughout, and the colour beautifully bright and white, like steel. With a new steel file, and Mr Alexander Bryson's assistance, I next proceeded to rub down as much of the surface of one of the pieces, as would suffice for a minutely detailed chemical analysis being made; and in assisting to do so, soon made a practical discovery of the extreme hardness or toughness of the metal, which in a comparatively short time turned the sharp points on the file itself. The hands soon became much blackened by the operation, as if plumbago was mixed with the iron. There seemed no doubt the metal was steel, from the carbon which was so manifestly present. The surface of the mass varied somewhat in its resistance to the file; its prism-like point was very close and hard externally, and contained apparently more of the blackening part of the iron; the upper and rounded portions were also harder and denser, at least externally, offering more resistance to the file. The tool seemed also to have less effect upon the iron when it was used across the mass, than in its longest diameter. Its hardness, as shown by a graving tool, was greatest next its outer surface—the inner portions being apparently softer, and more open in texture, while the prism-like point was tougher before the tool, and more like hammered iron; the explanation probably being—that this peculiarity was due to the shock of its fall being given principally to this part of the mass; and also, from its being suddenly cooled by the contact of its surface with the earth in which it was found buried.

The filings, of which about a troy ounce were procured, were black, and showed little of the shining metallic appearance of pure iron.

Chemical Analysis.—The filings were sent for examination to Dr Murray Thomson, who gives details of their composition in his subsequent communication. (See Analysis of Meteorolite, by Dr Murray Thomson.)

Test of Etching by Acid.—Each portion of the iron has been partially etched with the acid used by engravers on steel, which consists of equal parts of nitric and acetic acids; and the etched surfaces show the rough, irregular, projecting lines of the crystalline structure of the mass; which have been apparently but slightly acted on by the acid, from the presence of nickel; the dark lines and spaces showing where the acid has acted with greater effect. The acid was applied in the usual way for etching, and appeared to bite all at once, and that pretty deeply; it was then removed, the surface of the metal washed, and the acid reapplied, when it acted very slightly, and soon ceased to act altogether, not biting any deeper into the surface of the metal. The rough etched surface is characteristic of meteoric iron, various bright lines or points being observed in the fine frosted like appearance of the crystalline or fibrous surface of the metal. This etched surface is finer and more minute in its texture than that of any meteoric irons, the etchings of which I have been able to examine, suggesting a more minute subdivision of the particles of the iron and nickel, and a more general mixture of the nickel through the mass.*

A steel-plate, treated in exactly a similar manner as this meteoric iron, was exhibited, and showed simply a regularly smooth depressed portion where the acid had been applied.

These etched patches, having been placed near the middle of each surface of the two portions of the meteorite, perhaps rather unfortunately, give to a careless observer the idea of the mass having a core or central part of a different structure; this appearance is of course due entirely to the action of the acid.

Printed Impression from Etched Surface.—I was anxious

* Mr R. P. Greg of Manchester informs me this minute texture resembles the structure of the iron also found in Britain, and described by him, more than any other meteoric iron known; only the minute markings of his specimen appeared to be more angular and sharp in character.

to learn if it would be possible to get a cast or squeeze in wax, taken from the etched surface, on each of the two portions into which the mass was cut, that it might be electrotyped, and the electrotype cast (which thus exactly corresponds to the original surface of the iron) backed up with metal in the usual way, so that impressions might be printed from it. The cast taken from the larger patch of etching was so large, and the raised markings so slightly defined in their character, that, when it was used as a woodcut, the printer could not prevent it getting blotted all over, when attempting to take an impression from its surface. The smaller etched patch, from its less size, and possibly slightly more defined markings, was found to answer better, and an impression of it is accordingly exhibited, which gives a *fac simile* of the etched surface and structure of the metal.



Impression of Etched Surface of the Meteoric Iron.

The cast has been printed from, in the same manner as a woodcut, and shows the projecting parts black, the light spaces between being the more deeply etched parts of the surface, and the smooth polished metal surrounding the whole, appearing like a black border. The white spots which cross the picture show traces of the decay and line of the fracture, by which the mass became separated into two portions; for I was rather startled to learn that the process of taking the wax squeeze from the surface of the smaller half of the meteorite with the ordinary printer's press, had broken it in two. It was evident, however, from the fractured surface, which was simply a weathered

looking or oxidised continuation of the deep furrow which partially surrounded the mass, that this furrow had penetrated much deeper than was suspected, and that the few scattered dark spots, like corrosions on the polished surface of the sections, were the termination of the inner portions of this very furrow, part of the decay of which might be caused by the exposure and weathering the mass had undergone, in the five-and-thirty years of its existence on the surface of the earth; the origin of the furrow being due to the lobulated arrangement of the mass.

Weight of each of the Sections of the Meteorite.—Dr Murray Thomson has furnished me with the following notes of the weight and specific gravity of the two portions of the meteorite:—

“Of the two pieces, one was lighter than the other and weighs:—

In air, 13 lbs. 4 oz. 10 drs. (Avoir.)

In water, 11 „ 3 „ 13½ „ „

The larger and heavier mass weighs:—

In air, 18 lbs. 3 oz. 12 drs. (Avoir.)

In water, 15 „ 6 „ 1 „ „

The specific gravity of the first is therefore . 6·364

and of the second, . 6·385

“It is strange that neither of them should quite come up to the specific gravity of the mass when it was whole, which was, as formerly stated, . 6·517”

The difference in the specific gravity of these two portions may be explained, it seems to me, by the presence, in the smaller portion of the mass, of this large furrow, filled up with earthy-looking matter* of lighter specific gravity.

In conclusion, I may add a few notes on the general subject of *aërolites*.

Theories of the Source or Origin of Aërolites.—Various theories have been at different times brought forward to account for the presence of *aërolites*, these strange and apparently accidental visitors.

* Dr Thomson afterwards examined some of this earthy-looking matter, and found it to consist of the same chemical components as the rest of the mass, the iron, however, being in the state of an oxide.

These theories may be arranged in two great divisions :—

First, The terrestrial sources—the source or origin of these bodies being supposed to belong to our earth ; and, *secondly*, The cosmical sources, which derive their origin from beyond our earth. These again may be each subdivided into two sections, or classes :—

I. TERRESTRIAL SOURCES.

1. *Volcanic*—from the volcanoes of the earth.
2. *Atmospheric*—from their supposed formation in the atmosphere of our earth.

II. COSMICAL SOURCES.

1. *Lunar Volcanic*—from the volcanoes of the moon.
2. *Interplanetary Space*—the planetary or asteroidal theory.

I shall not enter here into the arguments that have been brought forward both for and against these various theories, merely remarking that the old idea of their terrestrial origin is now almost entirely given up. The second of these divisions, and in particular that which derives their origin from a supposed belt of planetoids or asteroids revolving in space on the borders, or just beyond the most distant part (from the sun) of the earth's orbit, being now generally considered as the view which meets and explains most easily the peculiarities of their structure and appearance ; I need only refer to the well-known memoirs on these subjects of Professors C. U. Shepard and J. L. Smith, M.D., of America,* and especially of Mr Robert Philip Greg of Manchester. M. Haidinger, director-general of the Geological Survey of Austria, has also published his views on the origin of aërolites, in a recent communication to the French Academy of Science.

Catalogues of Meteors and Meteorolites.—Catalogues detailing the particulars of all known meteors, aërolites, &c., have been from time to time published. I may refer to those given in the Reports of the British Association, and to the very complete list by Mr R. P. Greg in the Report of the year 1860.

Aërolites may be supposed to have fallen on our earth from

* American Journal of Science.

the earliest periods of its history. I am not aware, however, of any instances that have been noticed connecting their existence with the earlier or geologic history of our globe. In the sacred Scriptures, such expressions as the *great stones*, and the hailstones, that were cast down from heaven, on the enemies of Israel, on the memorable occasion when an apparent interruption of the earth's motion took place (Joshua x. 11); and, again, the use of such terms, as *coals of fire*, in addition to the lightning, by the Psalmist, when speaking of the wonders of the Almighty (Ps. xviii. 12, 13), suggest, at least, the possibility of an allusion to these mysterious bodies at that early period.

Meteoric Stones worshipped.—In the book of Acts (xix. 35) we have reference made to the image of the Diana of Ephesus, which fell down from Jupiter, undoubtedly an aërolite. The fall of one of these bodies among an ignorant and superstitious people, with its attendant phenomena of fire and explosion, would naturally be considered as a message from the gods, and especially from the presiding deity of the district. Various instances of falls of this kind are noticed by ancient authors, whose statements we have no reason altogether to disbelieve. We have also instances of the fall of aërolites recorded in our own day being followed by similar results, as in a case noticed by the Rev. Baden Powell, M.A., &c., in his Report on Meteors to the British Association in 1859; of a stone-fall at Dooralla, near Loodianah, in 1815, when the natives worshipped it, and commenced subscriptions for erecting a temple over it. Two stones fell at Parnallee, near Madras, in 1857; and their fall was followed by exactly the same results—crowds of natives worshipping the larger stone, “as the image of their deity, which had fallen from heaven” (see Silliman’s American Journal of Science, No. 32, Nov. 1861). One of these stones weighs 130 lbs., and is the largest meteoric stone known; it is now, I am glad to say, deposited in the British Museum.

There seems little doubt that meteoric falls were one, at least, of the causes of the stone-worship of the ancients, instances of which are represented on their coins, under canopies or shrines. The Diana of Ephesus is not represented in this

way, although on an ancient medallion given as an illustration to a learned paper on the Coins of Ephesus, by Mr A. G. Akerman, and struck, he supposes, for those who came to wonder and to worship at her shrine, there is a rude mummy-like figure of the goddess, and on its head, if not simply an imperfect *modius*, with which she is often represented, something which reminds one of the very distinctive shape of a meteoric stone or *aërolite* (Numismatic Chronicle, vol. iii. 1841, p. 118).

Mr Akerman, in a paper on the Stone-Worship of the Ancients, illustrated by their Coins (Numismatic Journal, 1838), since pointed out to me by Mr G. Sim, also refers to the probability of *aërolites* being objects of worship.

Map of Meteoric Stone and Iron Falls.—The illustration of the subject of *aërolites* would be increased if, in addition to these published catalogues, we had also a map showing their fall over all the world. I would be especially anxious, in a map of this kind, that a careful distinction be made (by colour or otherwise) between metallic, and earthy or stone falls; a distinction which, it appears to me, has scarcely been kept sufficiently in view by some writers, when considering the question of the distribution of *aërolites*. Had we such a map, we could judge at a glance whether meteoric falls were generally pretty uniform in their distribution over the earth, according to Mr Greg; or whether there are any signs of the local aggregation of these bodies in particular districts, as in the two so-called meteoric zones of Professor Shepard.

Have Meteoric Falls any relation to Terrestrial Magnetism?—We already possess maps, giving us the rain-fall over the world; and what a pleasure it is, when studying them, to be able to turn to other maps of allied phenomena, as, for example, the map of the winds, and to see at once how these different agencies act and react upon each other, and how the one map helps to explain to us the other. If we had our map of the *aërolite* falls, could we turn to any other map in our physical atlas that would help us to understand them any better? I cannot tell—but would be greatly interested in examining and comparing with it the maps illustrating the difficult subject of our terrestrial magnetism, and would be

anxious to see whether the one threw any light, or appearance of light, at all on the other. To enable me the better to judge of this, I would carefully distinguish all *metallic* from *earthy* meteoric falls, and would be curious to observe whether the apparently irregular scattering of the former over the world could be seen to bear any particular relation to the various centres of greater magnetic force.

There are four poles or maxima of magnetic attraction known to exist in our earth, a stronger and a weaker, in the northern hemisphere; and also a stronger and a weaker pole in the southern hemisphere. Supposing I have correctly stated these views of our terrestrial magnetism, it does seem interesting to find an observer like Professor Shepard coming to the conclusion, from entirely different data, of the existence of the two meteoric zones, which at once attract me by their position, appearing to bear some relation to these northern poles of magnetic force. He tells us, he finds the meteoric zone of the old continent rather strangely translated farther to the north than that of the American continent; this seems also to show a relation between terrestrial magnetism and these meteoric falls, as it is stated that the northern pole of magnetic force of the Old World (the weaker of the two), lies a good many degrees farther north than that of the New World.

Another fact, which is rather a puzzling one, is the very great relative proportion of *metallic* falls which have been discovered in America, as compared with any other part of the known world—thirty-two meteoric irons having been found in the United States, according to Professor Shepard, twenty-three of which are included in his meteoric zone. While only fourteen meteoric irons (whose time of fall is unknown) have been recorded as found in the Old World, and eleven of these falls are included in its so-called meteoric zone.* Mr Greg gives the number of localities of meteoric irons in the Western Hemisphere as fifty-seven; those of the Eastern Hemisphere being twenty-seven.† Various explanations have been given of these facts; it is rather curious, however, to observe, that in the New World we have the greatest

* American Journal of Science, 1850.

† Essay on Meteors, 1855.

number of metallic falls apparently in the neighbourhood of the very locality where the magnetic force is described as being in a maximum in the northern hemisphere. The metallic falls of the Old World seem also to bear a relation to the other northern magnetic pole; though, from its force of attraction being relatively weaker, it may be, the number of these metallic aërolites here is less, and the concentration of them together would also appear to be less; the meteorites straggling, in their deposition, to greater distances from its centre, and so adding to the apparent length of this so-called meteoric zone. Can these various circumstances be dependent simply on an accidental coincidence? or do they not, at least at first sight, suggest the idea that this strange agent of magnetism has really something to do with these peculiar arrangements?

Writers on terrestrial magnetism tell us, as one of the ascertained results of their labours, that the agents of the greater part of the magnetic force of the earth are situated exclusively in the interior of the earth, although minor magnetic oscillations and influences on its surface are due, without doubt, to the direct magnetic influence of the sun and moon; still these are only minor influences, the great magnetic force of the earth being situated exclusively in itself. Now, in my ignorance mayhap of the question, it does not seem to me to be a thing past belief, that when the earth in its orbit comes into the neighbourhood of the region in which these aërolites are now believed to exist; and, when their occasional proximity is close enough to bring the attractive powers of the earth—the greater mass, to overbear that of the smaller—the aërolite; besides, the mere attractive force of gravity dragging it down to the earth, that mysterious agency, the earth's magnetic attraction, should also come into operation; and, that a greater influence should of course be exerted over those bodies which are purely metallic, the component parts of which being also magnetic, are all strongly acted on by this magnetic influence; so that, as the daily revolution of our world takes place, the metallic meteoric falls would especially occur, as near as possible, to the poles of the greatest magnetic force; or at least as near as would be compatible with the power of

the other forces which might assist in attracting them to the surface of the earth. The possible, shall I say probable, result being, that *metallic* meteorites, other things being equal, would be found clustering in greatest numbers near the points of the earth's greatest magnetic force, at the time of their fall ; and, the stony meteorites, attracted magnetically in a less degree, would, from the more general causes of their attraction, be spread more abroad over the general surface of the globe.

Of course the poles or points where the magnetic force is in a maximum state, in the southern hemisphere, would also have their share of these metallic masses ; but with these regions we are comparatively unacquainted, and must not forget the greater presence of water—the sea—in this part of the world, which hides at once any meteoric fall that might take place on its surface. Metallic meteorites, however, are not altogether unknown in Australia, two very large masses having recently been discovered within some twenty miles of Melbourne. A friend of mine, just returned from Melbourne, tells me he has seen portions of them, and they somewhat resemble the piece of iron I have exhibited.*

Whether there may be any truth in these theories or not, I cannot determine, only they make me the more anxious that we should be possessed of a map of reference of these strange phenomena ; and I hope our townsman, Mr Alexander Keith Johnston, will be good enough to give my hint of a map of the “ Distribution of Aërolites over the Surface of the Earth ” † his favourable consideration, when preparing for publication a new edition of his valuable national work, the “ Atlas of Physical Phenomena.”

* One at least of these masses has been lately secured for the British Museum.

† Mr Greg of Manchester has since informed me that a map of meteoric falls has been published in Germany ; he does not, however, state whether the author has made a point of distinguishing the *metallic* from the other meteoric falls.

Analysis of the Meteorolite described in the foregoing paper by Dr J. A. Smith. By MURRAY THOMSON, M.D., F.C.S.,
Lecturer on Chemistry.*

In giving a chemical description of this remarkable mass of meteoric iron, I have to call attention, in the first place, to its specific gravity. The process of doing this was first performed on the undivided meteorite, and afterwards on each of its halves. Of course, with such a weighty mass this process could not be done by means of the ordinary delicate balance. I had therefore recourse to the standard beams and weights contained in the office of the Inspector of Weights and Measures at the County Hall, Edinburgh. The weight in air of the whole mass was 32 lbs., 11 oz., $1\frac{1}{2}$ drs., avoirdupois, equal to 39·60 lbs. Troy weight. The weight in water was 27 lbs., 10 oz., $13\frac{1}{2}$ drs. This gives a specific gravity, it will be seen, of 6·517, which is very low for meteoric iron. It stands at the lowest limit of recorded specific gravities of other meteoric irons. Shepard (Silliman's American Journal of Science, vol. ii. New Series, p. 377) gives the specific gravities of iron and nickel meteorolites as ranging from 6·5 to 8·00. After the mass had been divided, the specific gravity was taken in a similar manner to the above, and the heaviest and most solid half gave a specific gravity of 6·385. The analysis was made on some filings of the mass obtained after polishing the surfaces of the halves. I should have preferred for this purpose a sample derived from various parts of the mass, but this, it would appear, was not easy to obtain without endangering the good appearance of the meteorolite.

There is no point in the analysis calling for special description, except, perhaps, the determination of the nickel. This metal was estimated by dissolving a known weight of the meteorolite in hydrochloric acid, and after separation of the gangue of carbon and silica, the iron was peroxodized by heating with nitric acid, and then the iron oxide was precipitated

* Read before the Royal Physical Society, April 23, 1862.

by carbonate of baryta, and the excess of baryta afterwards removed by sulphuric acid. The precipitate of sulphate of baryta was removed by filtration, and the filtrate presented a decided green colour, which on concentration was deepened, showing the amount of nickel it contained to be considerable. The nickel in this solution was then precipitated and weighed as oxide. To arrive at a good result, it was necessary to operate on as much as 60 or 70 grains of the meteorolite. In the course of this process other metals, such as manganese, chromium, cobalt, &c., were carefully sought for, but no trace of them could be discovered. The qualitative analysis, therefore, showed the presence of iron, nickel, carbon, and silica; and these are present in the following proportions per cent.:—

Iron,	.	.	.	.	93.51.
Nickel,	.	.	.	.	4.86.
Silica,	.	.	.	.	0.91.
Carbon,	.	.	.	.	0.59.
					99.87.

It will be seen, therefore, that its composition is very simple, and not unlike that recorded in the analyses of other observers.

It may be remarked, in conclusion, that the occurrence of nickel in it, in such marked quantity, sets at rest any question that might be raised as to its meteoric origin. Though one or two pieces of undoubted meteoric iron exist without any nickel in their composition, yet that metal is held by Shepard (*vide* Silliman's Journal, *ut sup.*) to be the second most frequently occurring constituent.

[Several Reviews and Notices of Books have been postponed till October for want of space.—ED. N. Phil. Jour.]

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 17th February 1862.—PROFESSOR KELLAND,
V.P., in the Chair.

The following Communications were read :—

1. On the Condition of the Salmon Fisheries of England and Wales in 1861 ; with a Notice of some of the Modes of Fishing, especially those practised in the Severn and Wye. By Sir William Jardine, Bart., F.R.S., &c.

(This paper is given in the April number of this Journal.)

2. Cases of Poisoning by Goat's Milk. By Alexander E. Mackay, M.D., Surgeon H.M.S. " Marlborough."

3. Note on the Electricity developed during Evaporation and during Effervescence from Chemical Action. By Professor Tait and J. A. Wanklyn, Esq.

One of Professor W. Thomson's Divided-Ring Electrometers having been recently procured for the Natural Philosophy collection in the University, we have made use of it in repeating and extending the experiments of Volta, Pouillet, and others, on the electricity produced during the evaporation of various bodies. In some cases our results agree with those already known, but in others we find effects differing totally in kind or degree from the accepted ones ; and with some substances we find occasionally contradictory indications among our own results.

The Electrometer is in every respect a far superior instrument to the gold-leaf electroscope, which (sometimes with the addition of a condenser) was used by former experimenters, and enables us to give our results in a form easily reducible to absolute measure. The charge of the instrument was such that, when the half rings were respectively connected with the zinc and platinum of a single Grove's cell, the deflection observed amounted to about 5·8 scale divisions. This was found to be the most useful charge for the bulk of our experiments, but it was easily increased twenty or thirty fold when we sought to verify any very delicate indications.

Our apparatus consisted of a platinum dish, placed on an insulating stand, and connected with the insulated half ring. A lamp could be placed on the stand so as to heat the dish; and while

this was going on the indications of the electrometer gave us the atmospheric charge. The experiments were all conducted when the latter was very small, so that although the sputtering of the fluids dropped on the hot plate may have prevented us from observing some slight effects, the large deflections we observed in many instances can have nothing to do with the electric state of the air of the room. With a different disposition, which enabled us to use a Bunsen lamp to heat the dish, we obtained the atmospheric potential by burning a little ether or alcohol on the dish itself, when the lamp was removed.

We agree generally with previous experimenters, that during the continuance of the spheroidal state, there is little, if any, perceptible disengagement of electricity. We also agree with the statement that the main effect is produced while the fizzing sound that accompanies the loss of the spheroidal state is heard, and that during the continuance of the mechanical action to which that sound is due, the indications of the electrometer in general steadily increase. That the greater part of the electricity produced is due to friction is proved by the fact that, when fluids are forcibly squirted upon the hot dish, the electrical indications are very much increased, and that a concave surface gives far more powerful deflections than a convex one at the same temperature. The sputtering or violent boiling which succeeds the fizzing state, shows little, if any, disengagement of electricity. The principal interest of the results which we have obtained is in the cases of iodine, bromine, and various other bodies which do not seem to have been before examined. We have as yet met with no discordance in our own results as far as *simple* bodies are concerned.

In giving the following numbers, we have not attempted any correction for the loss of electricity which is caused by the high temperature of the platinum dish.

Mean Electric Effects given by a few substances during the continuance of the fizzing sound which immediately follows the disappearance of the Spheroidal State, 5.8 representing the Electromotive Force of a Single Grove's Element.

Bromine, ...	+ 400
Iodine, ...	+ 90*
Bromide of Ethyl, ...	+ but very small indeed, if any
Iodide of Methyl, ...	{ In many experiments strong +, but in three cases pretty strong -
Benzole, ...	No effect
Valerianic Ether, ...	No effect
Common Ether, ...	Very slight and dubious effects
Chloroform, ...	- if plate very hot, + if colder
Ammonia, ...	- 200

* This sample was in fine crystals. Far higher effects (also positive) were obtained from it in powder.

Alcohol, ...	- 10
Mercury, ...	- 75
Chloride of Sulphur, . .	- 100
Water (distilled), containing only a trace of carbonic acid, which was too small to be detected by lime- water, ...	- 80
Solutions in Water of—	
Carbonate of Potash (strong), .	- 310
Caustic Soda (strong), .	- 40
Do. (dilute), .	- 25
Caustic Potash (combustion strength), ...	+ 150
Nitric Acid (strong), .	+ 7.5
Do. (1 in 4 of water),	- 35
Hydrochloric Acid (strong),	- 160
Do. (weak),	- 50
Sulphuric Acid (strong),	+ 15
Strong solution of Na Cl .	- 400
Do. KI	- 80
Do. CuO, SO ₃	- 1000?
Solution of double Oxalate of Chromium and Potash, }	Very trifling effect
Fe, Cl ₃ , solution moderate,	Negative effect
Acetic Acid (Monohydrate),	+ 3
Acetic Anhydride, .	- 9

The sulphate of copper solution is by far the most remarkable that we have tried. The smallest globule, on leaving the spheroidal state, gave intense effects, sending the lamp image entirely off the scale.

We have also commenced a set of experiments with a view to test the electricity developed during the brisk disengagement of a gas by chemical action, which was discovered eighty years ago by Volta. In some of these experiments it was observed that when the gases were disengaged with considerable effervescence, and in a mass of large bubbles foaming over the platinum crucible in which the experiment was conducted, the bursting of each bubble was attended by a simultaneous increase of deflection in the electrometer. These experiments are, as yet, exceedingly imperfect, but they seem, like the preceding, to indicate friction as a main cause of the observed results. The effects on the electrometer are by no means so uniform, either as to kind or quantity of electricity, as those given by evaporation.

Electricity developed during Effervescence.

Zn + HCl	- 750
Zn + NO ₃ HO	+ 175. In another trial - 120

* This is a very difficult substance to experiment upon.

$MnO_2 + HCl$	.	.	- 150
$Ca O, CO_2 + HCl$	.	.	Trifling effects
$Na O, SO_2 + HCl$	.	.	{ At first a small negative deflection, finally + 50
$Na Cl + SO_2 HO$	.	.	
			+ 10

Monday, 3d March 1862.—DR CHRISTISON, V.P.,
in the Chair.

The following Communications were read :—

1. On the Pressure Cavities in Topaz, Beryl, and Diamond, and their bearing on Geological Theories. By Sir David Brewster, K.H.

In this paper the author gave a brief account of the various phenomena of fluid and gaseous cavities which he had discovered in diamond, topaz, beryl, and other minerals. He described—

1. Cavities with two immiscible fluids, the most expansible of which has received the name of *Brewstolyne*, and the most dense that of *Cryptolyne*, from the American and French mineralogists.
2. Cavities containing only one of these fluids.
3. Cavities containing the two fluids, and also crystals of various primitive forms, some of which melt by heat and recrystallise in cooling.
4. Cavities containing gas and vapour.

The author stated that the first class of cavities existed in thousands, forming strata plane and curved, and intersecting one another at various angles, but having no relation to the primitive and secondary planes of the crystal. From these facts he drew the conclusion that the minerals which contained them were of igneous origin ; and he considered this conclusion as demonstrated by the existence of what he calls *pressure cavities*, which are never found in crystals of aqueous origin. These microscopic cavities, which are numerous in diamond, exist also in topaz and beryl. The gas which filled them had compressed by its elastic force the substance of the mineral around the cavities, as shown by four sectors or quadrants of light which it polarises ; and consequently the mineral must have been in a soft or plastic state by fusion when it thus yielded to the pressure of the included gas.

2. On the Anatomical Relations of the Surfaces of the Tentorium to the Cerebrum and Cerebellum in Man and the lower Mammals. By William Turner, M.B. (Lond.), Senior Demonstrator of Anatomy in the University of Edinburgh.

Comparative anatomists have of late directed considerable attention to the determination of the relations of the cerebrum and cerebellum. This has been in great measure due to the publication by

Professor Owen of a system of classification of the Mammalia founded on their cerebral characters. The statement made by that eminent anatomist, that the posterior, or third, lobe of the cerebrum is peculiar and common to the genus *Homo*, and that equally peculiar are the "posterior horn of the lateral ventricle" and the "hippo-campus minor," which characterise the hind lobe, has led to much discussion. Various anatomists have published descriptions and drawings of dissections of the brains of many of the *Quadrumanæ*, especially of several of the higher apes. From these dissections, as well as from the older observations of Tiedemann and Cuvier, it may now be considered as fully proven, that in the *Quadrumanæ* the surface of the cerebellum corresponding to the superior surface of the human cerebellum is covered by the cerebrum; that posterior lobes, posterior cornua and hippocampi minores, are possessed by these animals.

In the mammalia lower in the scale than the *Quadrumanæ*, it appears to be the general opinion of anatomists that the posterior cerebral lobes do not exist, and that, from this circumstance, there is always a greater or less amount of cerebellum projecting behind the cerebrum, and uncovered by it. Tiedemann has, however, made an exception in favour of the seal, in which animal he says posterior lobes occur, although shorter than in the *Simiæ*. Cuvier also recognises the exceptional arrangement in the seal, and places along with it the otter and the dolphins. Retzius states, that in the mammalia lower than man, posterior lobes are found only in the apes, and that rudiments only are met with in the *Cetacea* and seals.

In the course of a series of observations which I have been making for some time back, on the crania of different mammals, my attention has been especially directed to the relative positions of the cerebrum and cerebellum. These observations have led me to come to the conclusion, that considerable misconception exists as to the relations of the two chief divisions of the encephalon.

If we turn to the descriptions of the cerebellum of man, given in our standard text-books of human descriptive anatomy, we shall find it stated that the cerebellum consists of a central median part—the vermiform process, or worm; and of two lateral lobes—the hemispheres. Of these, the hemispheres preponderate greatly in size. The cerebellum presents an upper and lower surface, and a circumference. The upper surface corresponds to the tentorium cerebelli; the lower is lodged in the concavity of the inferior occipital fossæ, to which it is accurately adapted. The circumference of the cerebellum corresponds to the line of junction of the upper and lower surfaces with each other, and along it a deep fissure, the great horizontal fissure, extends. The circumference—called also the posterior margin—corresponds, therefore, to the line of attachment of the tentorium to the transverse line of the occipital bone, and

marks with great precision the divergence of the two surfaces of the cerebellum from each other. Of these surfaces, that which is superior, and in contact with the tentorium, which we may therefore appropriately term tentorial, is the only one related to the cerebrum, the posterior lobes of which not only cover, but even project beyond it. The inferior surface, in contact with the occipital bone, which may therefore be termed occipital, never possesses any relation whatsoever to the cerebrum.

An examination of several members of most of the great orders of the class Mammalia has satisfied me, that it is quite possible to arrive in them at as correct a conception of the relations of the cerebrum to the cerebellum as in man. In every animal which I have examined, I have found the cerebellum to possess two surfaces. One of these is in contact with the tentorium, and, through the intervention of that membrane, is in relation to the cerebrum. The other is in contact with the wall of the occipital fossa. The surfaces are distinguished from each other by looking in different directions. The tentorial, corresponding to the superior in man, looks, as a rule, more or less forwards. The occipital, corresponding to the inferior in man, looks, as a rule, more or less backwards. These surfaces along their line of junction form an angle, more or less marked in different animals. This angle corresponds to the circumference, or posterior margin, of the human cerebellum, and is in contact with the line of attachment of the tentorium to the occipital bone. The tentorial aspect of the cerebellum, therefore, is that which is in constant relation to the cerebrum, and, not only in man, but in all the mammalia, is covered by it.

In a Chimpanzee, the tentorial surface of the cerebellum was directed upwards, and was evidently flatter than the corresponding surface in man. The occipital surface was directed downwards. The posterior margin was clearly marked. The posterior lobes of the cerebrum corresponded to the whole of the tentorial surface, and extended as far as the posterior margin of the cerebellum, beyond which they might even be stated slightly to project. The inferior vermiform process was lodged in a slight furrow between the two cerebellar hemispheres.

In the brains of several specimens of *Cercopithecus*, the tentorial and occipital surfaces, with the posterior margin of the cerebellum, were distinctly marked. In all, the posterior cerebral lobes extended over the tentorial surface as far as the posterior margin. In two of the brains, it might be stated that the cerebral lobes projected backwards beyond that margin. The comparatively greater development of the inferior vermiform process, over the lateral hemispheres of the cerebellum, was indicated by the absence of that fossa between the hemispheres in which it lies in the more highly developed human cerebellum.

In a Macacus, a vertical section through the skull and brain of

which animal I examined, the cerebrum corresponded to the tentorial aspect of the cerebellum; the posterior lobes of the one and the superior surface of the other extended as far as the margin of attachment of the tentorium to the transverse line of the occiput.

In two specimens of *Cynocephali*, the same relation of the posterior lobes of the cerebrum to the tentorial aspect of the cerebellum was observed. In neither of these brains was the inferior vermiform process lodged in a depression between the hemispheres, but formed an almost continuous surface with them.

In three brains, from animals of the genus *Ateles*, the posterior cerebral lobes extended quite up to the posterior margin, separating the tentorial from the occipital surface of the cerebellum. In all the lateral hemispheres projected slightly beyond the inferior vermiform process, which was lodged in a shallow depression between them.

In a lion monkey (*Midas leoninus*) the occipital surface of the cerebellum was separated from the tentorial by a very clearly defined posterior margin, as far as which the posterior cerebral lobes extended. The inferior vermiform process projected beyond the cerebellar hemispheres, which were comparatively feebly developed.

The Cetacea possess, not only in their great mass of brain, but in the number and complexity of the convolutions of their hemispheres, very decided evidences of a high degree of cerebral organisation. Professor Goodsir has allowed me to examine the brains of a porpoise, a bottle nosed dolphin (*D. Tursio*), and a porpoise (*Balaenoptera*), either in his possession, or in the Anatomical Museum. In all, in accordance with the peculiar antero-posterior compression of the cranial cavity, the corresponding diameter of the cerebral hemispheres was very much shortened, so that the brain was widened out, and heightened greatly in its vertical diameter. In all, the distinction between the tentorial and occipital surfaces of the cerebellum was very clearly marked. The cerebrum passed backwards as far as the posterior margin of the cerebellum. The cerebellum in them was a cerebellum inferius; for, as far as could be judged from an inspection of the brains, as they lay out of their cavities, the cerebellum was not exposed when looked at from above. The cerebrum possessed very decided posterior lobes; for, on account of the great extent of the tentorial surface of the cerebellum, and the heaping up of the cerebral convolutions in the vertical diameter, a large proportion of the cerebral hemispheres was placed above the cerebellum. The brain of the bottle-nosed dolphin had been lying for many years in spirit in the Anatomical Museum. A section had been made into the lateral ventricle on the right side, from which it appeared as if there were indications of a prolongation of the ventricle in the direction of the posterior lobe. When the dissection was extended, so as to obtain a more complete view of the arrangement, it was seen that the lateral

ventricle was continued backwards and outwards, sweeping along the posterior part of the optic thalamus. It then changed its direction, and passed downwards and forwards, so as to form the inferior horn. At, or about, the spot where this change took place, a recess, extending backwards in the substance of the cerebral mass was met with. This recess, from its position and curvature, must, I think, be regarded as a rudimentary posterior cornu. As the soaking of a brain in spirit, for a series of years, has a tendency to render the examination of the ventricular arrangements more difficult, than would be the case in a recent brain, I hope, in the course of the summer, to supplement this observation, by an examination of the brain of the common porpoise.

In the brains of those Carnivora which I have been able to examine, the cerebellum has been seen to possess tentorial and occipital surfaces, separated by a slight, yet definite, ridge, which corresponded to the line of attachment of the tentorium to the occipital bone. The cerebellum is not, however, so decidedly a "cerebellum inferius" as in the examples already described. The surfaces of the cerebellum consequently look more or less forwards and backwards.

In the otter, the cerebrum not merely covered the tentorial aspect of the cerebellum, but even projected beyond it in a very striking manner. Thus, when the brain was looked at from above, no part of the cerebellum was exposed. From the cast, it would appear as if the occipital surface of the cerebellum looked almost directly backwards. The cerebral hemispheres possessed considerable width posteriorly. In the seal, nearly the same relations prevailed as in the otter; the posterior projection of the cerebral hemispheres was more strongly marked laterally than in the middle line. This was due partly to the ossification of the tentorium and falx cerebri, and partly to the posterior cerebral fossæ not passing quite so far back in the middle line as they did somewhat further outwards.

Of the Pachydermata and Ruminantia, I have examined *in situ* the brains of the pig and sheep. In both these animals the tentorial and occipital surfaces of the cerebellum were clearly indicated by the line of attachment of the tentorium to the occipital bone. In both, the cerebral hemispheres extended backwards as far as that line, so that the tentorial surface of the cerebellar hemispheres was completely covered by it. In the pig, the tentorial surface of the cerebellum was larger proportionally than in the sheep, so that the extent of cerebrum in relation to the cerebellum was greater. When the brain of either animal was examined from above, a partial projection of the cerebellum behind the cerebrum might be seen; but the exposed surface was the occipital, and not the tentorial. From an examination of the brains, preserved in spirit, of the Warthog (*Phaco-chæres*) and Peccari (*Dicotyles*) in the possession of Professor Goodsir, it would appear, that in them, as in the common pig, the tentorial surface is covered by the cerebrum.

In the Rodentia, Insectivora, Cheiroptera, and Marsupialia, the cerebellum is no longer placed below the cerebrum, but behind it, so that it becomes really a cerebellum posterius. From the statements which have been made in the works of several anatomists of great distinction, it would appear to be their opinion that the cerebrum has, in these orders, so slight a relation to the cerebellum, that the *corpora quadrigemina* are more or less exposed between the two. From an examination which I have conducted *in situ*, of the brains of several members of these important groups, I think it very doubtful whether such a general statement is correct. Of the Rodentia, I have examined the rabbit, guinea-pig (*Cavia cobaia*), and rat. In all these animals it was quite possible to distinguish a tentorial and occipital surface in the cerebellum. The area of the former was small, and possessed a forward direction. The latter was much larger, and at first sight appeared to be the only surface which the cerebellum possessed. It was directed more or less upwards and backwards. The separation between the two surfaces was indicated by a slight ridge which corresponded to the line of attachment of the tentorium to the occipital bone. As far as this line the cerebrum extended posteriorly. The anterior surface of the cerebellum was thus in relation, through the tentorium, with the cerebrum. Owing to the limited area of this surface, the amount of cerebrum in relation to it was necessarily extremely small, and might be considered as little more than the posterior edge of the cerebral hemispheres. Neither in the rabbit nor guinea-pig could the *corpora quadrigemina* be seen, until the cerebral hemispheres were drawn on one side, or the cerebellum pushed back. In the rat, the hemispheres of the cerebrum were in relation to those of the cerebellum; but, in the middle line, owing to their divergence from each other at the posterior end of the great longitudinal fissure, the upper aspect of the *corpora quadrigemina* could be seen. When a bird's-eye view of the brain was made, a large proportion of cerebellum was exposed lying behind the cerebrum, but this exposed surface was the occipital.

Of the Insectivora, I have dissected *in situ* the brains of the mole and hedgehog. Of the Cheiroptera, I have dissected but one species. In these animals the surfaces of the cerebellum had about the same relation, as regards direction and size, as in the Rodentia. In all, the small tentorial surface was in apposition with little more than the posterior edge of the cerebrum. In none of the animals examined could the *corpora quadrigemina* be seen until the cerebral hemispheres were turned on one side.

Of the Marsupialia, through Professor Goodsir's kindness, I have been enabled to examine two brains of the kangaroo (*Macropus*). Although these brains had been for some time in spirit, and had evidently to some extent lost their original form, yet it was possible to distinguish in them the tentorial and occipital surfaces of the cerebellum, and to note that the cerebrum had to the former a rela-

tion corresponding to that which had been noted in the mammals already described. In the kangaroo, therefore, the exposed surface of the cerebellum is the occipital. The *corpora quadrigemina* could not be seen until the cerebral hemispheres were drawn to one side.

3. On the Connection between Organic Force and Crystalline Force. By H. F. Baxter, Esq.

(This paper appeared in the April number of this Journal.)

Monday, 17th March 1862.—DR CHRISTISON, V.P.,
in the Chair.

The following Communications were read :—

1. On a recent Landslip. By the Rev. John Duns,
Torphichen.

(This paper appears in the present number of this Journal.)

2. On the Rainfall in the Lake District in 1861. With some Observations on the Composition of Rain-Water. By John Davy, M.D., F.R.SS., Lond. and Edin.

3. Observations on the Absorbing Power of the Human Skin. By Murray Thomson, M.D., F.C.S., Lecturer on Chemistry, Edinburgh. Communicated by Dr Douglas MacLagan.

For the last sixty years physiological and other authors have been maintaining two very opposite views in regard to the absorption by the skin of substances dissolved in the water of baths. Some authors holding that such salts as iodide of potassium readily reach the blood through the skin, when applied in the form of a bath containing that salt; while others hold that absorption, under such circumstances, never takes place.

My experiments were all made on my own person at various intervals during the last two years. Six of them were made on as many successive nights, so as to try if frequency of bathing rendered the skin more permeable. The general method of making the trials was this :—Into an ordinary bath, a measured quantity of warm water was let, the temperature of which was recorded. Means were taken to keep the heat constant during the experiment. The temperatures ranged usually from 90° to 98°. The salt to be tried was then dissolved, and mixed with the water. The time in the bath was noted; it varied from half an hour to one hour and a quarter. The whole body was immersed, excepting the head and neck. All the urine voided in twenty-four hours after each bath was collected and concentrated, then tested for the substances experimented on.

Six baths were taken, in which iodide of potassium was dissolved. The quantity of the salt varied from 200 to 1300 grains.

Five baths, in which quantities of ferrocyanide of potassium, varying from 1400 to 5000 grains, were dissolved. Four baths were taken, the water of which was rendered strongly alkaline by soda. The result of these fifteen experiments was, that I could not find that any of the substances in the baths passed through the skin into the blood, so as to be found in the urine; the soda baths did not render it alkaline, nor could I detect the other salts in it; and it is to be noted that the tests for them are extremely delicate.

The general conclusion which my experiments lead me to are, (1.) That though not denying that absorption by the skin of aqueous solution does take place, yet it seems to be the exception and not the rule. (2.) That medicated warm baths, whether natural or artificial, do not appear to owe any virtue they may have to the substances dissolved in them reaching the blood through the skin. At the same time, as there are other ways by which one can conceive such baths to operate on the system, it is not to be concluded that, because absorption may not take place, such baths are useless as therapeutic agents.

4. On the Constitution of Mannite. By J. A. Wanklyn, Esq., and Dr Erlenmeyer.

Chemists are in the habit of assigning to mannite the formula,



but the reasons which have hitherto been given for that formula seem not very conclusive. By a process of fermentation, alcohol and a number of other compounds of well established composition may be obtained from mannite; but inasmuch as disintegration takes place in this process, the formulæ of the products afford no guide to the constitution of the original body.

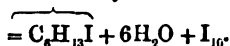
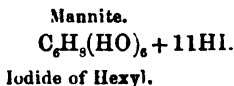
Up to the present time no compound of known formula has been got from mannite by other than disintegrating processes.

The uncertainty about the real composition of mannite has finally been illustrated by Berthelot, who in his "*Chimie organique fondée sur la Synthèse*," has proposed the formula,

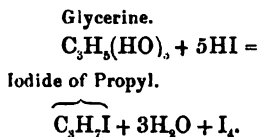


Berthelot has supported his view by bringing forward a number of salts of mannite, and has hinted at the possibility of preparing the substance from allyl compounds.

The reaction we have to bring forward in this paper is in contradiction to Berthelot. By distilling mannite with a great excess of strong hydriodic acid, in a stream of carbonic acid gas, it is almost completely resolved into Iodide of Hexyl. The change may be thus represented :—



This reaction is conclusive against Berthelot's formula, for it cannot be maintained that an easy reduction with hydriodic acid would increase the complexity of the carbon molecule. A parallel reaction between glycerine and hydriodic acid was observed by one of us some time ago.*



We are thus conducted to the result: mannite is the hexatomic alcohol of the C_6 series, or, as we prefer to write, Mannite is Hexyl-hydride, wherein six atoms of hydrogen have been replaced by six atoms of peroxide of hydrogen.

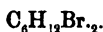
From the recognised connection subsisting between mannite and the sugars, we may expect that the sugars also belong to the Hexyl-hydride series.

Furthermore, just as glycerine has been got from the Propyl series, so may we hope to get mannite from the Hexyl series. It is our intention to attack this problem. We propose to make $\text{C}_6\text{H}_8\text{Br}_6$, and to endeavour by some means to effect a replacement of the Bromine by peroxide of hydrogen.

We subjoin a slight sketch of a few hexylic compounds. Iodide of hexyl $\text{C}_6\text{H}_{13}\text{I}$. (obtained from mannite), is a colourless liquid, having a smell very like that of iodide of amyl. It is very slowly acted upon by light; sp. gr. = 1.439 at 0°C . Boiling-point about 165°C . It can be distilled without suffering decomposition.

Hexyl-alcohol $\text{C}_6\text{H}_{13}\text{HO}$ may be obtained by decomposing the iodide of hexyl by means of oxide of silver and water. Its smell does not bear the slightest resemblance to that of amyl-alcohol.

Hexylene C_6H_{12} is obtained by digesting iodide of hexyl with alcoholic solution of caustic potash. It is a light oil, smelling like amylenes; boiling-point about 69°C . Its vapour-density has been found to be 2.88 and 2.97. The formula C_6H_{12} requires 2.9022. It combines with great violence with bromine, yielding



Hexyl-hydride, C_6H_{14} , may be obtained by decomposing the iodide with zinc in presence of alcohol. It is a light oil, having a very fragrant smell, and not attacked by Bromine at any rate in diffused daylight. In these two particulars it differs widely from

* Erlenmeyer. *Zeitschrift für Chemie u. Pharmacie*.

hexylene, which has an abominable smell, and which hisses when Bromine is dropped into it. In boiling point there is very little difference between hexylene and hexyl-hydride.

All of these compounds have given satisfactory analyses.

Monday, 7th April 1862.—THE VERY REV. DEAN RAMSAY,
V.P., in the Chair.

The following Communications were read:—

1. On the Structure of *Lerneopoda Dalmanni*, with Observations on its Larval Form. By Wm. Turner, M.B. (Lond.), and H. S. Wilson, M.D., Demonstrators of Anatomy.

This apparently little known form of parasitic crustacean has been as yet described only by Retzius and Kröyer. It does not appear, up to this time, to have been recognised as a British species. During the present year, many specimens obtained from the nasal cavity of more than one *Rasa batis*, caught by the Newhaven fishermen, have been examined by the authors.

Female.—One of the largest of the Lerneadæ, divided into cephalo-thorax and abdomen by a constricted neck. Cephalo-thorax $\frac{1}{10}$ ths of an inch long; it projected almost at a right angle from the anterior end of the abdomen. On its dorsal surface were a pair of 3-jointed hooked antennæ. In front of the antennæ, and close to the anterior end of the head, was the buccal apparatus. Situated in the middle line was a short, conical, retractile snout, which possessed an oral aperture bounded by two fringed lips at its extremity. The structure of these lips, with that of the jaws and palpæ connected to them, was then fully described. On each side of the snout is a short stump-like process—a modified foot. It was segmented, and possessed a bifid, free extremity, the posterior division of which was armed with a terminal hook; the anterior division, much larger than the posterior, was studded with short bristles. Connected to the base of each stump-like process was a segmented palp-like structure, set with three or four conical papillæ at its free end.

Springing from the sides of the cephalo-thorax, immediately in front of the neck, was a pair of elongated cylindrical arms. Each arm ended superiorly in an expanded clasper. The two claspers were in close contact by flattened, opposed surfaces, but not united together. In the concave upper surface of the opposed claspers a cartilaginous-like bar was placed. The authors then described the structure of the arms and the bar, and the mode of connection of the parasite through these arrangements to the wall of the nasal chamber of the skate. The structure of two bulb-like protuberances from the sides of the cephalo-thorax, immediately in front of the roots of the

arms, was then described. These were the eye-like spots of Retzius and Kröyer.

Abdomen $\frac{1}{7}$ ths of an inch long, $\frac{1}{6}$ ths broad; had an inverted heart-shaped form; imperfectly defined segmented appearance. The fourth segment, the largest, possessed a median slit-like anal aperture, two elongated ova strings, and two posterior abdominal appendages. The arrangement of the intestinal canal, ovaries, and cement organ was then described. The authors then pointed out certain appearances which they considered indicative of the existence of a nervous system.

The authors agreed with Milne-Edwards in thinking that the elongated cephalo-thorax and the posterior abdominal appendages point decidedly to the advisability of separating this animal from the genus *lerneopoda*. None of the specimens they examined had the male attached, so that they have not examined it. They have seen the larvæ in various stages of development. When free, the larva was $\frac{3}{8}$ th of an inch long and $\frac{1}{6}$ th of an inch broad; oval when viewed from dorsal surface; profile view showed a convex dorsal and almost flat ventral surface. It possessed a pair of antennæ and two pairs of limbs. Each of the first pair of limbs was bifid, the two branches bearing long hairs at their extremity. Each of the second pair was bifid, the two branches bearing each a spinous hook at its extremity. A remarkable tail-like prolongation, fringed with pinnate hairs, was then described. The curved intestinal canal, the eye spots, and the pigment masses within the visceral chamber, were then adverted to.

2. *Memoir of the Life and Writings of Robert Whytt, M.D., Professor of Medicine in the University of Edinburgh, from 1747 to 1766.* By William Seller, M.D., F.R.S.E., F.R.C.P.E.

3. *On a difficulty in the Theory of Rain.* By James Dalmahoy, Esq.

The difficulty which the paper discusses is the paradoxical fact discovered by Dr Heberden,—namely, that if there be three exactly similar rain-gauges, and one of them be placed on the ground, the second on the roof of a neighbouring house, and the third on a still higher edifice, then, notwithstanding every variety in the positions of these gauges as respects surrounding objects, and notwithstanding the prevalence of the opposite conditions of high wind and of absolute calm, it is observed that the lowest gauge receives more rain than the middle one, and the middle gauge more rain than the upper one.

The paper endeavours to show the inadequacy of the explanations

which have hitherto been given of this difficulty, and quotes, on this point, the authority of Sir John Herschel. It then proceeds to prove, both theoretically and by observation, the existence of a slow downward current of air mingled with minute globules of water, the current itself being the effect of the rain, and originating in the cloud from which the rain proceeds. The twofold agency of this downward current in producing the paradoxical results is then explained; and the paper concludes with a numerical estimate, the object of which is to prove that the quantity of water which it is necessary to assume as being contained in a given volume of the atmosphere, at a given time, in order to account for even the more remarkable results on record, is too small to give rise to the appearance of cloud; and so, by proving this, to obviate what would otherwise have been a formidable objection to the proposed explanation of the phenomenon.

4. On the Structure of the Bark of *Araucaria imbricata*, with special reference to Palæontology. By John Hutton Balfour, A.M., M.D., F.R.S., Sec. R.S.E., Professor of Medicine and Botany.

The frost of December 1860 caused serious damage to trees and shrubs in the Botanic Garden of Edinburgh. On the morning of 24th December, Fahrenheit's thermometer stood at 6° below zero, according to the Kew standard. An account of the injury inflicted has been already published in the Transactions of the Botanical Society of Edinburgh. It has been stated that the great cold in the garden, as compared with other places near Edinburgh, may be accounted for by its low sheltered situation, and the descent of the heavy cold atmosphere from the more elevated localities around.

Among the plants which suffered were two very fine specimens of *Araucaria imbricata*, which had stood for upwards of thirty years, and one of which had attained the height of 24½ feet, with a circumference of 4 feet at the base of the stem, and with twenty whorls of branches. These trees, which were great ornaments of the lawn in front of the range of hothouses, have been cut down. An opportunity was thus afforded of examining the structure of their wood and bark. The former is very hard and heavy, and promises to be valuable timber. In regard to the latter, the scars and markings, and their relation to the leaves, seem to deserve special notice. The sharp-pointed triangular hard and spirally arranged leaves are remarkably persistent. None of the plants in the garden have ever shed their leaves. They become sometimes of a brown colour; but even then they continue to adhere to the stem, and appear as unsightly appendages. In one of the plants cut down the leaves show a splitting at the base, apparently from dis-

tension in the parts underneath, similar to what takes place in the petioles of many palms before they are detached. It is possible that, in the *Araucaria*, the splitting of the basis of the leaves may sometimes be the precursor of their fall. From the lower part of the leaves prolongations extend along the surface of the bark, and give rise to peculiar markings, which are well seen when the leaves are cut off close to their union with the stem (fig. 1). The base of the

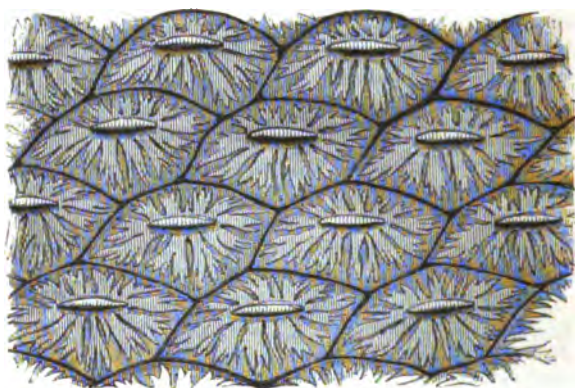


Fig. 1.

leaf remaining in the bark has the form of a narrow elongated ellipse, surrounded by cortical foliar prolongations. The markings on the bark, viewed externally, have a somewhat oblique quadri-

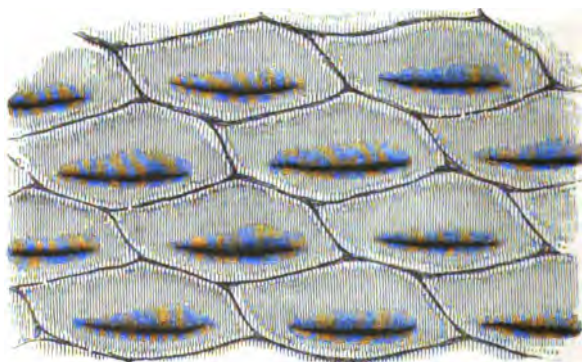


Fig. 2.

lateral form. The leaves, when examined by the microscope, show stomata on both surfaces, running in lines, not unlike the appearance presented by stomata in *Equiseta*.

On removing the epiphloeum or outer bark, and examining its inner surface, we remark a difference in the appearance presented at the lower and upper part of the stem. In the lower portions the markings have an irregular elliptical form, with a deep depression, and fissures where the leaves are attached (fig. 2). Higher up the epiphloeal markings assume rather more of a quadrilateral form, with the depressions less deep, and the fissures for the leaves giving off prolongations on either side. Farther up the markings are smaller in size, obliquely-quadrilateral, and present circular dots along the boundary lines chiefly (fig. 3). Higher still the

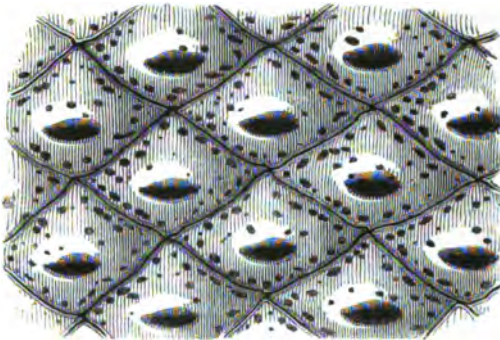


Fig. 3.

quadrilateral form becomes more apparent, and the dots disappear (fig. 4). The epiphloeum thus presents differences in its markings at different heights on the stem.

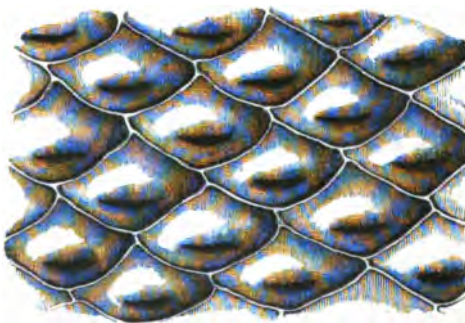


Fig. 4.

The middle part of the bark, or mesophloeum, is well developed, and is of a spongy consistence. When examined microscopically it is seen to be composed of cells of various shapes—some elongated fusiform, others rhomboidal, others with pointed appendages. The

variety of forms is very great, and it is possible that this may be partly owing to the effects of frost on the cells. On the spontaneous separation of the bark, the mesophlœum was seen to consist of distinct plates of a more or less quadrilateral form, with some of the edges concave and others convex, a part in the centre indicating the connection with the leaf, along with which it is detached. In fig. 5 a leaf is shown with a mesophlœal plate attached.

The endophlœum, liber or inner bark, is of a fibrous nature, and consists of elongated woody tubes.

The appearances presented by the outer and middle bark of *Araucaria imbricata* bear a marked resemblance to those exhibited by certain fossils included in the genera *Sigillaria* and *Lepidodendron*. The sculpturesque markings on the stems of these fossil plants have induced geologists to look upon them as allied to the ferns and lycopods of the present epoch. But it is evident, from the specimens of *Araucaria* now laid before the Society, that much caution is required in making this determination. Other points of structure must be examined before a proper decision can be formed; when, for instance, the presence of scalariform tissue, or of punctated woody tissue has been satisfactorily shown under the microscope, we are entitled to hazard an opinion as to the affinities of the fossils. In many instances, however, external appearances are the only data on which to rely for the determination of fossil genera and species; and rash conclusions have often been drawn by geologists who have not been conversant with the structure of plants.

The *Araucaria* markings point out the need of care in drawing conclusions, and their variation at different parts of the bark indicate the danger of a rash decision as to species. There can be no doubt that in vegetable palæontology the number of species has been needlessly multiplied—any slight variation in form having been reckoned sufficient for specific distinction. We can conceive that the *Araucaria* bark markings in a fossil state might easily supply several species of *Sigillaria*, or of *Lepidodendron*. The geologist, with little knowledge of the present flora of the globe, ventures often to decide on an isolated fragment, which a well-informed botanist would hesitate to characterise. Hence the crude descriptions of fossil vegetable forms, and the confusion in which Palæophytology is involved. Every geologist who examines fossil plants ought to be well acquainted with the minute structure of living plants, the forms of their roots, stems, leaves, fronds, and fructifica-

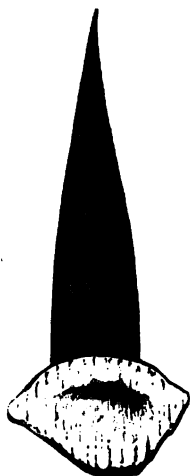


Fig. 5.

tions; the markings on the outer and inner surfaces of their barks, on their stems, and on their rhizomes; the localities in which they grow, and the climates which genera and species affect in various parts of the world.

Monday, 21st April 1862.—PROFESSOR CHRISTISON, V.P.,
in the Chair.

The following Communications were read:—

1. On the Theory of Numbers. By H. Fox Talbot, Esq.
2. On the Carboniferous Volcanic Rocks of the Basin of the Forth. By Archibald Geikie, Esq., F.R.S.

After referring to a previous communication to the Society, in which the author had given an outline of the chronology of the igneous rocks of Scotland, he proceeded in the present paper to describe in detail the character of the volcanic phenomena in one district—that of the carboniferous system of the Forth basin. The igneous rocks of this district consist partly of doleritic and felspathic lava-form masses, and partly of various kinds of ash or trap-tuff. These materials present a considerable diversity in their modes of arrangement. But the author had found that all the volcanic hills of the district might be reduced to three types of structure:—1. A simple cone of ash, round and over which the ordinary sedimentary accumulation of the carboniferous period had been deposited. 2. A cone of ash with the crater filled up by a neck or plug of basalt. 3. Sheets of different lavas with intercalated ash or sedimentary matter.

He described in detail the succession of volcanic phenomena in the Lothians and in Fife, pointing out how local and limited the eruptions had been as a whole. They were confined to the earlier half of the carboniferous period, no interbedded igneous rock having yet been found in the formations that overlie the carboniferous limestone. The whole of this district appears to have been dotted over with volcanic cones, from each of which independent eruptions took place. To such a kind of scenery the nearest parallel in Europe is probably the region of Auvergne and the Haute Loire, which the author had recently visited for the purpose of comparison. The concluding part of the paper was devoted to a sketch of the subterranean movements of upheaval and depression which can be shown to have taken place during the volcanic period in the basin of the Forth, and to some remarks on the abundance of life in the immediate vicinity of the volcanic orifices.

3. On the Constitution of Society in this Country, with reference to the Proportion which Male Life bears relatively to Female Life, and the Effects of an Excess of Female Life. By W. T. Thomson, Esq.

(This paper has been published as a pamphlet.)

4. On the Danger of Hasty Generalisation in Geology. By Alexander Bryson, Esq.

5. On the Deflection of the Plummet caused by the Sun's and Moon's Attraction. By Edward Sang.

In this paper it was shown that the attraction of the sun causes a deflection of the plummet, having its maximum about the 240th part of a second, and proportional to the size of twice the sun's zenith distance; the deflection is at its maximum when the sun is 45° above or below the horizon, and occurs in the vertical plane passing through the attracting body.

The deflection due to the moon has its maximum about the 60th part of a second, and follows the same law; it is toward or from the attracting body according as the zenith distance is less or more than 90° .

Upon the cross-level of a transit instrument, the joint effect is to cause a semi-diurnal oscillation small at the quarters and rising to the 24th part of a second at new and full moon; while the influence upon meridian observations is sufficient to cause a disagreement between the greatest inclination of the moon's orbit, as observed at St Petersburg and Madras, amounting to the 50th of a second.

The general conclusion drawn was, that we cannot determine the positions of the heavenly bodies true to the 100th part of a second without having made allowance for this source of disturbance.

6. Note on Gravity and Cohesion. By Professor William Thomson.

The view, founded on Boscovich's theory, commonly taken of cohesion, whether of solids or of liquids, is, that it results from a force of attraction between the particles of matter, which increases much more rapidly than according to the inverse square of the distance, when the distance is diminished below some very small limit. This view might, indeed, seem inevitable, unless the idea of "attraction" is to be discarded altogether; because the law of attraction at sensible distances—the Newtonian law—demonstrated by its discoverer for distances not incomparably smaller than the earth's dimensions, and verified by Maskelyne and Cavendish in a manner rendering it impossible for any naturalist to reasonably doubt its applicability

to the mutual action between particles a few hundred yards or a few inches asunder, seems to give only very small, scarcely appreciable, forces between bodies of such masses as those we experiment on in our laboratories, everywhere placed as close as possible to one another,—that is to say, in contact, and does not seem to provide for any considerable increase of attraction when the area of contact is increased, whether by pressing the bodies together, or by shaping them to fit over a large area.

But if we take into account the heterogeneous distribution of density essential to any molecular theory of matter, we readily see that it alone is sufficient to intensify the force of gravitation between two bodies placed extremely close to one another, or between two parts of one body, and therefore that cohesion may be accounted for without assuming any other force than that of gravitation, or any other law than the Newtonian. To prove this, let two homogeneous cubes be placed with one side of each in perfect contact with one side of the other; and let one-third of the matter of each cube be condensed into a very great number, i , of square bars perpendicular to the common face of the two; and let the other two-thirds of the matter be removed for the present. The mass of each bar will be $\frac{1}{3i}$ of the whole mass originally given in each cube.

Let us farther suppose that the two groups of bars are placed so that each bar of one group has an end in complete contact with an end of a bar of the other. The attraction between each two such conterminous bars, however small their masses are, may be increased without limit, by diminishing the area of its section, and keeping its mass constant. But the whole mutual attraction between the two groups exceeds i times the attraction between each of the conterminous pairs, and may therefore be made to have any value, however great, merely by condensing each bar in its transverse section, and keeping their number and the mass of each constant.

We may now suppose another third of the whole mass to be condensed into bars parallel to another side of the cube, and the remaining third into bars parallel to the remaining side. If, then, either of these cubes be placed with any side in contact with any side of the other, and allowed to take the relative position to which it will obviously tend—that in which the bars perpendicular to the common side of the two cubes come together end to end, there will be produced, by pure gravitation, a force of attraction between them which may be of any amount, however great, and which will be greater, the greater the ratio of the whole space unoccupied within the boundary of either cube, to the space occupied by the matter of the bars.

This illustration has been chosen merely for the sake of definiteness and simplicity; but it is clear that any arrangement, however

complex, of woven fibrous structure, provided only the ratio of the unoccupied to the occupied space is sufficiently great, will lead to the same general conclusion. Farther, it is clear that the same result would be produced by any sufficiently intense heterogeneousness of structure whatever, provided only some appreciable proportion of the whole mass is so condensed in a continuous space in the interior that it is possible, from any point of this space as centre, to describe a spherical surface which shall contain a very much greater amount of matter than the proportion of the whole matter of the body which would correspond to its volume. Except in imposing this condition, the theory now suggested interferes with no molecular hypothesis hitherto propounded, continuous or atomic, finite atoms, or centres of force, static or kinetic.

Physical science abounds with evidence that there is an ultimate very intense heterogeneousness in the constitution of matter. All that is valid of the unfortunately so-called "atomic" theory of chemistry seems to be an assumption of such heterogeneousness in explaining the combination of substances. This alone, it is true, does not explain the law of definite combining proportions; but neither does the hypothesis of infinitely strong finite pieces of matter; and whatever is assumed to be the structural character of a chemical compound, a dynamical law of affinity between the two substances, according to the proportions of them lying or moving beside one another, must be added to do what some writers seem to suppose done by their "atomic theory."

It is satisfactory to find that, so far as cohesion is concerned, no other force than that of gravitation need be assumed.

Monday, 28th April 1862.—PROFESSOR CHRISTISON, V.P.,
in the Chair.

The following Communications were read :—

1. Experimental Inquiry into the Laws of the Conduction of Heat in Bars, and into the Conducting Power of Wrought Iron. By Principal Forbes.

The experiments described in this paper were all made in 1850 and 1851, upon a plan which was fully explained by the author in letters to Mr Airy and Professor Kelland in the former year. Some notice of them appeared in the British Association Reports for 1851 and 1852, and the apparatus was supplied by a grant from the Association.

In previous inquiries into the thermal condition of a long conducting bar heated at one end, two assumptions have always been made: *First*, that the flux of heat across any transverse section of

the bar is proportional throughout to the rapidity of the decrement of temperature reckoned along the axis of the bar (or to $\frac{dv}{dx}$, where v represents the temperature, above that of surrounding space, of any point of the axis of the bar at a distance x from the origin). *Secondly*, That the loss of heat by radiation and convection from the surface of the bar is at every point proportional to the same temperature v . By assuming these principles (the last of which is certainly more or less inexact), the well-known solution of the problem of the heated bar is, that the temperatures (or excesses of temperature) diminish in a geometrical progression from the origin, and finally, of course, become insensible. Previous experimenters have confined themselves to finding the constants of the logarithmic curve for different substances, and thence their *relative* (not absolute) conducting powers.

In the experiments now described, neither of the above-mentioned principles is assumed. The external loss of heat is *directly* ascertained by experiment, and the admissibility or otherwise of the former principle is also *directly* tested. That principle may be thus symbolised: $F = -k \frac{dv}{dx}$, where F is the flux of heat

across unit of section, k the conducting power for the substance employed, and v and x have the same signification as before.

I. In the first instance, a bar of iron 8 feet long and $1\frac{1}{4}$ inch in diameter, was heated by means of a crucible at one end, containing melted solder. Thermometers were inserted at various points of its length. The results, v in terms of x , were projected in a curve (approximately a logarithmic), and the values of $\frac{dv}{dx}$ were

found by projection or calculation, or both.

II. Next a short bar (20 inches long), perfectly similar in section and condition of surface to the long bar, is heated to above 200° Cent. in a bath of fusible metal, and allowed to cool in free space, a thermometer being inserted at the centre of its length. This gives us the rate at which such a bar is parting with its heat from all causes whatever, in terms of the temperature shown by a thermometer in its axis.

III. The losses of heat in unit of time (one minute) last found may be taken as representing the amount of heat dissipated from each point of the long bar in the statical experiment (I.), being given in terms of the temperature proper to each point of such a bar. A curve may thus be constructed, having for its line of abscissæ the axis of the long bar, and for ordinates, the rate of dissipation of heat from each portion of its surface due to both radiation and convection.

IV. If we can by mechanical quadrature, or otherwise, find the



whole amount of heat dissipated between any point of the long bar and its coolest extremity, we have, in truth, the flux of heat passing from the hotter extremity of the body across the particular section in question; for the condition of permanence of the temperature of the bar arises from the equality of the heat supplied and dissipated. But the whole heat dissipated in unit of time is the integral of the partial dissipations represented by vertical ordinates of the last-named curve, taken between any assumed point x and the farthest or cool end of the bar. This quantity, then, is F or the flux across unit of section at the point x .

V. We are now able to resolve the question whether or not the flux of heat is in the given bar everywhere proportional to the rapidity with which the temperature decreases as x increases, or whether the equation holds, $F = -k \frac{dv}{dx}$, the conducting power k being supposed to be constant.

The following table (the result of an *approximate* reduction made in 1852) shows that the constancy of k in the case of iron cannot be assumed; on the contrary, that the conductivity diminishes as the temperature increases. The first column is the observed temperature of given points of the bars; the second and third columns give the values of k from the preceding equation—(1.) as deduced from experiments on the iron bar with a polished surface; (2.) when the surface was covered with thin paper. The general coincidence of the two is satisfactory, since the external cooling was considerably different in the two cases.

Actual Temperature, Centigrade.	$\frac{F}{-\frac{dv}{dx}}$; polished bar.	$\frac{F}{-\frac{dv}{dx}}$; covered bar.
25°	 0136	 0147
50	 0130	 0138
75	 0131	 0123
100	 0126	 0113
125	 0122	 0107
150	 0112	 0107
175	 0100	 0102
200	 0087	..... ...

The mean of both series may be tolerably represented by a uniformly diminishing conductivity as the temperature increases. When reduced* to the usual units of conducting power expressed in terms of the amount of heat necessary to raise by 1° Centigrade a cubic foot or a cubic centimètre (one gramme) of water respectively, we have the following absolute measures:—

* The numbers in the preceding table refer to the thermal capacity of iron instead of water.

Temperature, Centigrade.	Conducting Power of Wrought Iron.			
	Units, the Foot, Minute, and Cent. Degree.		Units, the Centimètre, Minute and Cent. Degree.	
0°		·0133	.....	12·36
50		·0120	.....	11·15
100		·0107	.....	9·94
150		·0094	.....	8·73
200		·0082	.....	7·62

It is to be observed that thermometric readings have not yet been finally corrected, so that these numbers may receive some slight modification. The author hopes to complete the verification of the calculations, so far as wrought iron is concerned, in the course of the present summer. The state of his health has been the cause, not only of the suspension of the experiments, but of the long delay which has taken place in publishing the results so far as obtained.

2. On Certain Vegetable Formations in Calcareous Spar. By Principal Sir David Brewster.
3. On the Existence of *Acari* between the Laminæ of Mica in Optical Contact. By Principal Sir David Brewster.
4. On the Secular Cooling of the Earth. By Professor William Thomson.

The fact that the temperature of the earth increases with the depth below the surface, implies a continual loss of heat from the interior by conduction outwards, through or into the upper crust. Since the upper crust does not become hotter from year to year, there must therefore be a secular loss of heat from the whole earth. It is possible that no cooling may result from this loss of heat, but only exhaustion of potential energy, which in this case could scarcely be other than chemical affinity between substances forming part of the earth's mass. But it is certain that either the earth is becoming, on the whole, cooler from age to age, or that the heat conducted out is generated in the interior by temporary dynamical action (such as chemical combination). To suppose, as Lyell has done,* that the substances combining together, according to the chemical hypothesis of terrestrial heat, may be again separated electrolytically by thermo-electric currents due to the heat generated by their combination, and thus the chemical action and its heat continued in an endless cycle, violates the first principles of natural philosophy in exactly the same manner and to the same degree, as to believe that a clock constructed with a self-winding movement may fulfil the expectations of its ingenious inventor by going for ever.

Adopting as the more probable, the simpler hypothesis that the

* Principles of Geology.

earth is merely a heated body cooling, and not, on the whole, influenced to any sensible degree by interior chemical action, the author applies Fourier's theory of the conduction of heat to trace the earth's thermal history backwards. From data regarding the specific heat and thermal conductivity of the earth's substance, he investigates the time that must elapse from an epoch of any given uniform high temperature throughout the interior, until the present condition of underground temperature could be reached. Taking into account the very uncertain character of the data when high temperatures are concerned, he infers that most probably either the whole earth must have been incandescent at some time from 50,000,000 to 500,000,000 years ago, or that at some less ancient date, but still anterior to the earliest human history, there must have been up to the surface a temperature above the boiling-point of water. Either alternative—or indeed any theory whatever consistent with the principles of natural philosophy regarding previous conditions of the earth—is as decisive against the views of those naturalists who acknowledge no creation of life on the earth within fathomable periods of time, as the plainest elements of dynamics are against those who maintain that we have no evidence in nature of an end.

5. Notice of the Ravages of the *Limnoria terebrans* on Creosoted Timber. By David Stevenson, Esq., F.R.S.E., M.I.C.E., &c.

The author stated that it would be difficult to estimate the value of any chemical or mechanical process whereby timber might be rendered permanently impervious to the ravages of the *Limnoria terebrans*, that small but sure destroyer of timber structures exposed to the action of the sea.

The justly approved creosote process, patented by Mr Bethell, had been largely employed in railway works, with universally admitted success, and, in common with many of his professional brethren, the author adopted it in several marine works, in the expectation that it would prove an antidote to the *Limnoria*; but he had now ascertained beyond all doubt that creosote was not a universal or permanent preservative of timber used in such works.

6. On some Thermic Properties of Water and Steam. By Professor W. J. Macquorn Rankine.

The author refers to the general equation of the mechanical action of heat which Professor Clausius and he arrived at independently by different methods in 1849, and points out that the form of that equation, which was laid before the Society by him in a paper read on the 4th of February 1850, comprehends, as a particular case, the

law which connects the volume of a given weight of steam with its temperature, pressure, and latent heat. He describes the use of that law, with proper numerical data, to compute, in the absence of direct experiment, tables of the density and volume of saturated steam, more accurate than those founded on the assumption of the perfectly gaseous condition, as exemplified in tables which he published in 1855 and subsequently. Referring next to the direct experiments of Messrs Fairbairn and Tate on the density of steam, published in the Philosophical Transactions for 1860, he gives a tabular comparison of the volumes of one pound of steam as determined by these experiments, and as computed theoretically from M. Regnault's experiments on the latent heat of steam, with the aid of Joule's mechanical equivalent of heat; and from that comparison he draws conclusions which may be summed up as follows:—

1. At temperatures below 212° , the differences between the results of theory and experiment are inappreciable.

2. At temperatures above 212° , the differences, although too small to be of any consequence in practical calculations connected with steam-engines, are appreciable, the volume of a pound of steam by theory being slightly greater than by experiment.

3. Small as those differences are, there exist no known sources of error either in the data of the theoretical calculation or in the method of experimenting sufficient to account for them.

4. They are therefore most probably caused by some unknown difference in the molecular condition of the steam in M. Regnault's experiments on latent heat, and in Messrs Fairbairn and Tate's experiments on density.

5. That difference of condition is probably connected with the fact, that in M. Regnault's experiments the steam was in rapid motion from a boiler towards a condenser; whereas in the experiments of Messrs Fairbairn and Tate the steam was at rest.

6. Further experimental researches are desirable.

7. Formulæ connected with small continuous Displacements of the Particles of a Medium. By Professor Tait.

Royal Physical Society.

Wednesday, 26th March 1862.—ALEXANDER BRYSON, Esq., President, in the chair.

The following communications were read:—

1. *Notice of Indian Insects exhibited at last meeting by Mr Elliot of Wolflee.* By R. F. LOGAN, Esq.

2. Dr James M'Bain exhibited what were believed by the fishermen to be the ova of the herring. He described the development in the

ovum, and also exhibited the small fry, which eight days ago had proceeded from these ova.

3. *On the Differences between the Young Herring, Clupea harengus, and the Spratt, Clupea sprattus.* By J. M. MITCHELL, Esq.

4. *On Phryxus paguri.* By JOHN ANDERSON, M.D.

5. *Observations on British Zoophytes and Protozoa.* By T. STRETHILL WRIGHT, M.D.

1. *Clava nodosa* (new species, T. S. W.) Polypary Creeping. Soleroderm membranous, "Polyps single, small, aurora coloured, each springing from a small knot of convoluted tubes." This zoophyte was found on the fronds of *Delesseria sanguinea* at Queensferry and Largo. The very delicate threads of the polypary creep over the fronds of the seaweed, and at intervals twine themselves into a convoluted knot of membranous tubes, from which a single polyp arises. The species occurs only at low tide mark; while *C. repens*, for which it may be mistaken, is found in shallow rock pools.

2. "Polypary branched, spirally twisted. Polyps pale orange, with two rows of tentacles. The lower row from 4 to 12, the upper row from 2 to 8 capitate."

On stones carrying *Caryophyllia Smithii*, received from Ilfracomb. This little tubularian was about a quarter of an inch high, with three polyps, and resembled in habit *Tubularia larynx*. It bears the same relation to *Vorticlava* that *Corymorpha* does to *Tubularia larynx*.

3. *Zootieira religata*.—I described this animal to the Society about three years ago. It is a stalked actinophrys. The body, as in other animals of this class, consists of two elemental tissues, to which I have given the terms ectosarc and endosarc,—terms which have been adopted by Dr Carpenter. The ectosarc or external tissue is prolonged into a thick brush of the most delicate contractile palpocils or tentacles, like threads of spun glass, by which the animal is constantly seizing small organic particles, and conveying them to the endosarc or inner tissue, which is the nutritive element. I stated that the stalk was formed of a prolongation of the ectoderm, similar to the tentacles; but, having again discovered large colonies of these animals last summer, and again this winter, I have been enabled to study the structure of the stalk more closely, and find that it is an elastic tube, which appears to consist of denser tissue than either of the elements of the body. The axis of the tube is occupied along its whole length by a powerful muscular band, which is well seen in the figure in which the tube is distended with water, as sometimes occurs. The animals are very sluggish, remaining for days motionless, with all their rays extended; but the moment they are touched they vanish, drawn close down by their powerful muscular apparatus into the interstices of the shells in which they are generally found. *Zootieira* multiplies by gemmation, the buds being given off close to the stalk, and separate as a minute actinophrys, which instantly fixes itself and develops its stalk.

4. *Freya (Lagotia) obstetrica et Freya styliifer*, (new species, T. S. W.)—It is now some years since I described several species of the new genus *Lagotia* to the Society. It appears, however, that Claparede and Lachmann had already constituted the genus *Freya* for animals evidently belonging to my genus *Lagotia*, in a memoir which they communicated to the French Academy, which memoir was printed after my communication to this Society. The species of *Freya* discovered by them differed from any of my species, and I have now to describe two other

species of this very remarkable genus. *Freya obstetrica*.—"Lobes of rotatory organ very broad, not folded; the tips bluntly rounded and incurved, so as to resemble very closely the blades of the obstetric forceps. Body fusiform, scarcely longer than the rotatory lobes. Nucleus large, colourless, surrounded by dense green pigment. Body and rotatory lobes covered with striæ, bearing fringes of cilia. Cell flask-shaped, without a trumpet-shaped mouth. Colour of animal and cell pale bluish green."

Freya styliifer.—"Rotatory lobes short, narrow, and widely expanded, one of the lobes bearing at its tip a fleshy prolongation or style as long as the lobe; cell tubular, without trumpet-shaped mouth; cell and animal colourless." *Freya styliifer* is the smallest species I have yet seen of the genus to which it belongs; when contracted within its tube, it projects the curious style, which is doubtless a sense organ, beyond the opening, only entirely retracting it when rudely disturbed.

During the last summer I had an opportunity of watching another species of *Freya* (*F. producta*) building up its remarkably constructed cell. The cell of this species, which is often immensely prolonged, is formed of a spiral ribbon of chitine, cemented by a thick internal layer of soft green sarcodæ, secreted by the body of the animal, so that the whole forms a hollow tubular spring, like the spiral wire tubes formerly employed for conveying gas to moveable burners. These tubes will therefore bend aside like a willow twig on any rude contact from the animals which are constantly coming dashing about, and will instantly regain their proper position. The young *Freya producta*, which is a free swimming larva, fixes itself, and secretes the lower part or body of the cell from the outer surface of its body; it then begins to form the elongated neck by depositing the chitine and sarcodæ on the upper edge of the constantly lengthening ribbon, carefully moulding the plastic materials with its two short rotatory lobes, which it uses like a pair of hands, just as *Sabella* and *Serpula* mould their tubes with their hand-like secreting leaflets. Having built its tube to the requisite length, it finishes it off with a handsome trumpet-shaped mouth, and then retires to develop its long rotatory lobes. Occasionally the animal outgrows its dwelling-place, and finds it necessary to lengthen its tube. For this purpose a large quantity of dark green matter is collected in the body of the animal, a little below the rotatory organ, and from this part chitine and sarcodæ are secreted, which are instantly moulded into shape by the rotatory lobes, and a new spiral tube rises up from within the trumpet-shaped mouth of the old one.

Chatospira maritima (new species, T. S. W.)—Two species of this remarkable animal have been noted by Lachmann—*C. Mulleri* and *C. mucicola*. *Chatospira* is defined as a *Stentor*, in which the ciliary spiral and the parenchyma of the body supporting it are drawn out into a long thin process. When the animal issues from its tube, it protrudes its ciliary organ as a fleshy column, fringed on one side by a row of very long motionless cilia, but in an instant the column is twisted into a spiral, and the cilia are set in violent motion, urging currents of water towards the mouth. The marine species approaches in character as to its rotatory organ, to *C. Mulleri*, while it inhabits a mucous tube like that of *C. mucicola*.

Oxytricha longicaudata.—This remarkable animal, resembling very much *Oxytricha retracts*, described by Claparede and Lachmann, was found in great numbers with *Chatospira maritima*. The tail in this species is fully twice as long as that of *Oxytricha retracts*, and is dragged after the swimming animal like a trailing rope, when suddenly the extremity of the tail is fixed by the long cilia at its extremity, and the *Oxytricha*, by violent contractions of its tail, jerks itself backwards and for-

wards in the most violent manner. The structure of tail, under an excellent power of eighty diameters, presents a peculiar striated and plaited appearance, like that of voluntary muscular fibre, but I could not make anything of it under higher powers.

6. *On peculiar hooked Spines on Ophiocoma bellis, with Observations on the Spines of other Ophiocomæ.* By CHARLES WILLIAM PEACHE, Esq., Wick.

7. *Geology of Moffat, Dumfriesshire.* 1. Lithology. By WILLIAM CARRUTHERS, Esq., F.L.S.

(This paper appears in the present number of this Journal.)

Wednesday, 23d April 1862.—JOHN COLDSTREAM, M.D., President, in the chair.

The following communications were then read :—

1. *Observations on the Phocidæ of the Greenland Seas.* By JOHN WALLACE, M.D.

2. (1.) *Notice of a Mass of Meteoric Iron found at the Village of Newstead, Roxburghshire, with some general remarks on Meteorites.* By JOHN ALEX. SMITH, M.D.

(This paper appears in the present number of the Journal.)

(2.) *Chemical Analysis of the Meteoric Iron found at Newstead, Roxburghshire.* By MURRAY THOMSON, M.D.

(This paper appears in the present number of the Journal.)

3. *On Professor M'Coy's Ray without a name, taken in the Firth of Forth, May 1861.* By WILLIAM S. YOUNG, Esq.

(Specimen exhibited.)

Wednesday, 7th May 1862.—JOHN COLDSTREAM, M.D., President, in the chair.

The following communications were then read :—

1. *Note of the Capture of the Red-Crested Whistling Duck (Fuligula rufina, Selby) in Argyleshire.* By JOHN ALEXANDER SMITH, M.D.

Dr Smith read a communication he had received from J. W. P. Orde of Kilmory, Esq., of the capture of a male of the *Fuligula rufina*, the red-crested whistling duck, which was shot in company with some golden eyes on a fresh water loch near Craignish, Argyleshire, in the month of January. This bird is a rare occasional visitor to England, and was first noticed by Yarrell in 1826. Several specimens have been since observed, but none before this in Scotland. It is a bird of eastern Europe, emigrating southwards in winter.

Dr Smith also read a note from Richard Bell, Esq., of a wild duck's nest, with eggs, noticed amongst the small branches of a thorn tree on the farm of Billholm, Dumfriesshire, in May 1861. It was eleven feet from the ground, and about forty yards from the river Esk. The nest was not the old one of any other bird, as crows, &c., which has sometimes been observed, but was the work of the bird herself. It was compactly built of birch twigs, and was lined with down. Instances of wild ducks occasionally using the nests of other birds, and at as great a height as thirty feet from the ground, have been observed. In these instances, it is believed, the young birds are brought down to the ground by the bill of the mother.

2. *On a Case of Abnormality in the Ossification of the Parietal Bones in the Human Fœtus.* By RAMSAY H. TRAQUAIR, Esq.

In this communication Mr Traquair carefully described the parietal bones of a fœtus, one of which was composed of two portions, the smaller one nearly the third of the size of the bone; it was therefore formed from two distinct osseous centres,—a very unusual variety, of which no exactly corresponding case was known, the bone being generally formed of one piece and from one osseous centre.

3. (1.) *Remarks on the so-called raised Sea Beach Bed, and its Relations to other Deposits in the neighbourhood of Leith.* By JAMES M'BAIN, M.D., R.N.

(2.) *Supplementary Communication on the so-called Raised Sea Beach Bed at Leith.* By ALEX. BRYSON, Esq.

4. *On the Equoreal Pipe Fish.* By T. STRETHILL WRIGHT, M.D.

5. *Observations on British Zoophytes and Protozoa.* By T. STRETHILL WRIGHT, M.D.

6. *Report of the Committee on Marine Zoology.* By GEORGE LOGAN, Esq., Convener.

The Committee in their report noticed the discovery of a fish, new to the Firth of Forth,—viz., the poor or power cod, *Gadus minutus* of Linnæus,—*Morrhua minuta* of Fleming, and described by Yarrell, vol. ii. p. 241, of his "British Fishes," in a very interesting manner. This little fish was first detected during the spring among a number of the common codlings, by Mr R. F. Logan,—the fishermen always confounding it with the whiting pout or brassey, the *Gadus luscus* of Linnæus, which it much resembles. Some of the specimens were found to be full of mature spawn. A fine specimen of the Greenland shark,—*Scymnus borealis*,—caught on the Dogger Bank 30th April 1862, was secured for the examination of the committee; and Mr Young has favoured them with a detailed description. Mr Young states,—“This specimen was presented to me by Mr Finlay, fishmonger, Leith, and this is only the sixth instance, so far as known, that the Greenland shark has been observed in our seas. Length, 8 feet 6 inches; greatest circumference, 3 feet 7 inches at posterior angle of pectoral fins. The colour was a uniform light-bluish grey, skin covered with minute hooked spines—hooks pointing backwards. A row of mucous ducts extended from the tail to the head, their apertures, four-tenths of an inch apart, forming the lateral line, which branches off at the head into symmetrical curves. These ducts are about half an inch in length, and communicate obliquely with a longitudinal canal just under the skin, lined with a dark pigment membrane. On dissecting the fish, the liver, consisting of two lobes, each 5 feet in length, weighed 35 pounds. In the stomach was found a large pultaceous mass, along with portions of the cat-fish, cod, and haddock, and a large cod-hook, with a part of snood attached. The claspers at the base of the ventral fin showed this to be a male fish; and an elongated testis, covered by a delicate membrane, extended on each side of the spinal column the whole length of the abdominal cavity. Three years since, in the month of May, a somewhat larger specimen than this was caught near Inchkeith, and is now preserved in the Natural History Museum here.”

7. *On the Composition of a Pseudo-Steatite found near Bathgate.* By MURRAY THOMSON, M.D., and MORD BINNEY, Esq.

(This paper appears in this number of the Journal.)

8. Mr Robert Brown exhibited a small foetal specimen of a Narwhal; another and larger foetus was also found in the uterus of the same fish, which was captured in Davis' Straits.

Botanical Society of Edinburgh.

Thursday, 13th March 1862.—Professor BALFOUR, V.P., in the chair.

Professor BALFOUR made a few remarks on the death of James Townsend Mackay, LL.D., M.R.I.A., Curator of the Botanic Garden, Trinity College, Dublin. Dr Mackay was a Nestor in botany, and was well known as the author of "*Flora Hibernica*." He died, 25th February last, of bronchitis, at Dawson Grove, near Dublin, at the age of 87. For many years he had been affected with paralysis. He was attended assiduously by his friend, Dr Croker. His remains were interred in the Jerome Cemetery. He was elected a member of the Society in December 1836.

The following communications were read:—

1. *Does Magnetism possess any Influence over Organic Forces?* By H. F. Baxter, Esq. Communicated by Professor BALFOUR.

(This paper appeared in the number for April.)

2. *Notes on Cyperaceæ, No. 2. On Scirpus Holoschænus and var. β (S. romanus).* By BENJAMIN CARRINGTON, M.D., F.L.S.

The author stated that in 1849 he received from the Edinburgh Botanical Society a variety of *Holoschænus* (Link), having a more graceful habit and differing from the Braunton Burrows plant, which is the typical form. The specimen was from Watchet. He described the plant under the Linnean name of *Scirpus australis*, and communicated the opinion of the late Mr Borrer on the subject.

3. *Notice of flowering Plants and Ferns, collected on both sides of Davis Straits and Baffin's Bay.* By Mr JAMES TAYLOR, Aberdeen. Communicated by Professor BALFOUR.

(This paper is in the present number of the Journal.)

4. *Remarks on Disease of the Beech.* By Mr R. G. FOGG.

The author remarked—For two or three years preceding 1858, my attention was directed to a disease which had proved fatal to some very fine specimens of beech in a gentleman's park in the county of Suffolk. The trees in question were greatly valued by the proprietor as objects of ornament, and various means were tried to effect a cure, and, if possible, to arrest the further progress of the disease, but without any beneficial result. The beech is one of the most accommodating trees as regards soil and situation, and it was evident that the disease did not arise from any peculiarity in the soil, which consisted of the sandy loam, with subsoil of chalk and gravel. In hot dry seasons the trees suffered much from drought. I mention this fact because I have seen the same form of disease among trees growing in wet, low-lying districts; and when seeking information from foresters and others interested in such matters, they have invariably attributed it to dampness of situation. The disease is caused by minute insects, and not as some have thought, by a species of fungus. The trunk of the tree is first attacked, and while some portions of it to all appearance remain in a healthy state, those which the insects infest gradually assume a dry appearance, and when closely examined, the bark will be found to separate from the wood, and become dry and lifeless. Other unfavourable influences may, of course, favour the speedy decay of

the trees, but it soon becomes evident that future healthy development is arrested, and when the trees are cut down the ravages of the insects cease with the life of the bark. This is, I think, the most curious circumstance connected with the disease, and may under careful investigation go some length to make us acquainted with means to effect its destruction. While the ravages of the insects seem to be confined to patches and districts of plantations, their existence is pretty widely spread throughout the country, and on trees growing under all circumstances. Attempts to effect a cure or to prevent the occurrence of the disease have, as far as I can ascertain, proved a failure. Other trees more valuable than the beech are in some places affected with a disease to all appearance similar: as, for example, the silver firs on the estate of Dunmore, near Stirling. Amongst the many plans adopted there, the only one which has succeeded to any degree is that of brushing with a *hard* brush the parts infected, when the bark was dry.

Specimens of the Nardoo plant of Australia were shown in a germinating state. The sporocarps had been sent to the Botanic Garden by Mr James Scoales, 1 Cassels' Place, Leith, and they had sprouted in a moist situation in the hothouse. Mr John Scott, one of the gardeners, took notes of the germination, and submitted the following statement:—The spore-fruits of the *Marsilea* consist of short legume-like capsules, containing sporanges of two kinds—*antheridial* and *ovulary*—on short receptacles arranged in a biserial manner on a mucilaginous cord. The *antheridial* spores consist of single cells, containing a great number of small granules, the functionary import and developmental history of which is differently explained by authors. Thus Lindley and Valentine regard them as abortive ovulary spores; while Hofmeister believes them to be the male organs of the plant, stating that each of the granules produces a number of spermatozoa. Schleiden, on the other hand, while agreeing with Hofmeister in regard to the functions they perform, maintains that they develop tubes somewhat similar to those produced, as he formerly supposed, by the pollen-grains of *Phanerogams*, one of which penetrates the ovulary spore, and is developed into the young plant. The ovulary spore, according to Schleiden, presents the following structure:—"A very large cell with firm walls, containing large grains of starch, mucilage, and oil. The embryo-sac is surrounded by a white coriaceous membrane, which is formed of very minute scarcely distinguishable cells. This membrane forms at one extremity a papilla, which is covered by a membrane open at the point, and called the simple coat of the bud." The spore-fruits immersed in water at a mean temperature of 65° Fahr. burst in two days, and emitted a gelatinous cord, one extremity of which was free, the other attached to the base of the fruit. This cord, through the absorption of moisture, expanded rapidly in various degrees—in one instance, under our own observation, it formed a filament two inches long by two-eighths of an inch in diameter; this, however, according to Schleiden, must be a minimum of the size it usually attains, as he states that it forms a round filament from one or two lines thick, and four to five inches long, exceeding in volume twenty or thirty times the whole fruit. It is on this cord, as formerly stated, that the receptacles bearing the *antheridial* and *ovulary* spores are arranged, the latter being confined entirely to their interior sides, the former covering the others; nevertheless, though a peculiar, they are not an exclusive, product of this part, as receptacles frequently occur void of ovulary spores, their places being then occupied by *antheridial* cells, and in general they are irregularly intermixed on this part with the latter—a fact which favours the conjecture of Lindley, that they are simply abortive ovulary spores. On detaching an ovulary spore from a receptacle, a small opaque papilla is observed protruding, which is the

point from which germination invariably takes place. If we place a few of these receptacles on moist soil, in a mean temperature of 65°, the papillæ are developed in a few hours into truncated conical tumours of green cellular tissue, usually a line long, covered with a delicate transparent membrane. This is called the prothallus, which is here, as in the *Lycopodiaceæ*, confluent with the spore. The development of the prothallus now ceases, and it gives off at a right angle to the axis of the spore the primordial leaf, which is straight and subulate, usually attaining half an inch in length, and partially sheathed by the membrane covering the prothallus. Before this leaf is fully developed the root has made its appearance in a line directly opposite to it, as a delicate fibre, destitute of the green granules which are found in the leaf. Shortly after the root has made its appearance a second leaf grows from the prothallus close to the first. This leaf at once bursts the sheath which had partially enveloped the latter. The vernalion of this second leaf is similar to the first; it differs from it, however, in form, as the petiole in this case bears an entire obovate lamina.

Professor Balfour read a letter from Dr Dubuc, of H.M.S. *Cossack*, written from Auckland, New Zealand. Dr Dubuc writes—"The *Cossack* arrived here with the Governor, Sir George Grey and suite, after a quick but stormy passage from the Cape. The Governor, who takes great interest in natural history, brought with him a Wardian case containing *Quercus virens*, a cactus with cochineal insects, a willow, and other plants likely to be useful in the colony. I have examined some of the plants of this neighbourhood. By the border of a rivulet I gathered many ferns, amongst them *Cyathea dealbata*, which is an elegant tree fern. I also observed *Phormium tenax*, New Zealand flax, in fruit, one of the useful economical plants. *Corypha australis*, which imparts a somewhat tropical feature to the scenery, *Altingia excelsa*, the Norfolk Island pine, and some Cape species may also be seen. Many of our common English weeds are abundant, such as *Ulex Europæus*, *Plantago lanceolata*, *Verbascum Thapsus*, *Geranium molle*, *Nasturtium officinale*, a common species of *Rumex*, and others. Through the kindness of the secretary, Mr Layard, I have been enabled to procure the desiccated body of a caterpillar with a peculiar fungus (*Sphaeria Robertsi*?) projecting from it. The spores of the fungus attack the body of the animal, and ultimately destroy it by their growth." A drawing of the caterpillar was sent.

Professor Balfour read the following extract from a letter of Dr Giraud, Professor of Chemistry in the Medical College of Bombay:—"I have travelled over nearly the whole of the Bombay Presidency, and have explored much interesting botany and geology. The last place we were at a few days ago was one of the most beautiful hills of the western Ghats called Mathoran, 2500 feet above the sea, and thirty miles from the coast, prettily wooded with *Siszygium*, *Sterculias*, *Erythrinæ*, *Memecylon*, *Ocotea*, *Sapota*, *Glycosmis*, *Actinodaphne*, &c., &c., with under shrubs of *Canthium* and lovely *Strobilanthes*, *Barlerias*, and *Ruellias*."

James G. Wilson, Esq., of Batavia, Craignenk Villa, Launder Road, exhibited specimens of twin coco nuts; each stalk producing two fruits, one of them fully developed, the other abortive and appearing in the form of a curved appendage. Mr Wilson stated that out of many thousand trees growing on the Coco Islands only one tree produced fruits like those exhibited, every fruit having the same appearance. Occasionally three fruits have been produced from the same peduncle, one being perfect, the other two abortive, having the same horn-like aspect. The tree was blown down about six years ago. Nuts have been sown by Mr Ross, the Governor of the island, and it will be interesting to learn if the progeny

produce similar nuts. Mr Wilson presented one of the specimens to the Museum of the Botanic Garden.

Mr M'Nab gave the following report on the flowering of plants in the open air in the Botanic Gardens:—*Sisyrinchium grandiflorum*, February 14; *Nordmannia cordifolia*, February 15; *Scilla bifolia* (blue) February 20; *Symplocarpus foetidus*, February 26; *Narcissus pumilus*, February 27; *Dondia Epipactis*, February 28; *Erica herbacea*, February 28; *Aubretia grandiflora*, March 8; *Arabis albida*, March 8; *Scilla bifolia* (white), March 10; *Scilla præcox*, March 10; *Primula denticulata*, March 12; *Scilla bifolia* (pink), March 12.

Wm. Tod, Esq., St Leonard's, Lasswade, sent specimens of peculiar lacerated varieties of *Lastrea dilatata*, and *L. spinulosa*, from Dumcrieff, near Moffat.

Thursday 10th April 1862.—T. C. ARCHER, Esq., President, in the chair.

Professor Balfour intimated the death of Dr Emilius Dubuc, of H.M.S. Cossack, who had been an active member of the Society, and had contributed to its Herbarium and Museum.

The following communications were read:—

1. *The Ahtoor Ghaut and the Ascent to the Shevaroy Hills from Madras*
By Dr ALEX. HUNTER, Madras.

On Friday, the 27th December 1861, I left Madras by the early six o'clock train, bent on enjoying a week's relaxation, and trying the bracing effects of the cool climate of the Shevaroyas. For the first twenty or thirty miles the country seemed to be a good deal under water, and the tanks and ditches were fuller than I had expected, considering the light monsoon. Some of the paddy crops were fair and promising, and the cool breeze blowing over the wet fields felt very refreshing. There is little to attract the eye beyond a long flat expanse of low level country, densely wooded in the vicinity of Madras, but becoming bare and uninteresting for nearly twenty miles. The Naggery range of hills, with the bolder Nullamullys to the north, stretching up along the Pulicat lake, are the first objects of interest. These hills were resorted to some years ago as a sanitarium, and were inspected and reported upon, but their height is not sufficient to command a cool bracing climate, and being only from 800 to 1200 feet above the level of the sea, the temperature is not much below that of the plains. On approaching Arcot and Vellore the hills become more rugged, bold, and picturesque. In parts of this range some hills have hardly a trace of vegetation from the base to the summit, while others are covered to the very top with brushwood. This difference seems to depend on the character of the decaying rocks of the hill, —the white pegmatites and pale gneiss rocks yielding a poor sterile soil, while the decomposing green-stone, dark granites, and trap rocks, yield more productive soils. This fact can be easily verified on several parts of the line—as, first, on the bold bare slopes of the Amoor Hill, where the stratified appearance of the pale grey gneiss can be well seen at a great distance. It may also be observed on several of the hills between the Arcot and Vellore stations, where the white pegmatites or binary granites are in all stages of decay; but their slopes are nearly all equally sterile. At 4.20 the train reached Ahtoor; and after a ride of nearly two miles through nearly level country, very richly covered with tall brushwood, thickly studded with a great variety of trees, all of a few years' growth, the village of Ahtoor was reached. In the vicinity of the village large patches of the jungle had been cleared for the cultivation of

castor oil, horse gram, sesamum, and earth or ground nut (*Arachis hypogæa*), from which a fine white oil is made. The castor-oil plant seemed very luxuriant, attaining a height of ten or twelve feet in some fields, while much that had been seen in the plains near Vellore was only three or four feet in height. In one field, a little beyond the village, along with the castor oil, there was cultivated a great deal of the cockscomb, or love-lies-bleeding, and of a begonia, used by the natives as a vegetable like rhubarb, and attaining a height of four to six feet. At five o'clock the foot of the ghaut was reached, and for about a mile the ascent was very easy, being through bamboo jungle, interspersed here and there with very fine straight tall trees, chiefly of the bombax or silk cotton, and *Eugenia jambolana*, with here and there a young promising teak (*Tectona grandis*), *Pterocarpus*, *Cassia*, or *Euphorbia*, the latter growing to the dimensions of a good large tree. Many of the trees were overhung with very picturesque creepers in great luxuriance, but most of them had passed into seed; amongst these were the *Cryptostegia*, which yields one of the finest India-rubbers, a very strong fibre from the bark, equal to that of the Yercum or to English flax, and a strong and feathery silk cotton around the seed. Among the other creepers were varieties of *Convolvulus* and *Ipomœa*, some, like the moon-creeper, attaining a gigantic size, and towering up to great heights, and dangling gracefully in festoons or wavy lines nearly vertically for twenty or thirty feet overhead. For about half a mile the bamboo jungle becomes very dense, and the stems attain a thickness of five or six inches. The trees diminish in number, as well as change in their character, being apparently harder, with their wood more knotted and gnarled. *Dalbergia latifolia* and *D. sissooides*, and a tree very like the true mahogany or *Swietenia*, were seen; this we believe to be a *Cedrela*, like the Toon-wood of Bengal. The *Pterocarpus santalinus*, a good red wood, here attains a considerable size. The road now became more steep, tortuous, and difficult. I stopped to admire the scenery and the gorgeous sunset. Below was the level, long expanse of country terminating in the Mysore ranges of hills, with here and there a little streak of water; and, as I afterwards learned, the river Cauvery can be seen in the distance. As the ascent for the last half mile had been rather steep, I dismounted and walked up to ease the pony; but I was soon warned by the attendants that it was only half way, and that we must push on as quickly as possible. For the next half mile the scenery became very varied and bold, from the winding nature of the road, and the large bare rocks piled one above another in the bed of the stream below. About eight o'clock I reached the welcome bungalow, and highest house on the Green Hills.

2. *On the Institution of Government Gardens at Travancore, Southern India.* By J. B. MALTEY, Esq., President, Travancore.

His Highness, the Rajah of Travancore, having liberally sanctioned the application of large sums towards the establishment of a public garden or gardens for the introduction into his kingdom of useful and ornamental plants, I proceed to state the manner in which I think that the object sought may be best advanced. The site selected for the principal garden is at Peermade, or rather at a new station named Maryville, a place which appears to be admirably suited for the purpose. It is at an elevation of about 3300 feet above the sea, and enjoys a temperate climate. It is on the line of the high road about to be constructed between Alleppy and Madura. There is every reason to hope that it is free from malaria, being exposed to the influence of the sea-breeze, and experience up to the present time bears out this expectation. The ground is undulating and the soil varied; forests and grass plains alternate with one another.

The thermometer (December) falls to 58 in the morning and rises to 73 under shelter at 2 p.m. The rainfall is not accurately known, but is probably about 100 to 125 inches. But the advantage of the site will be more apparent if the objects which chiefly call for attention at the present time are considered. These are, 1. Cinchona; 2. Tea; 3. Coffee; 4. Cotton; 5. Vanilla. The cinchona is of so much importance, that the garden may be viewed as formed to aid in the introduction into the mountainous country of Travancore of this invaluable tree, and the other objects may be considered as subordinate to this.

3. *On the Cultivation of Cotton in Mysore.* By C. B. SAUNDERS, Esq., Officiating Commissioner for the government of the territories of his Highness the Maharajah of Mysore to the Secretary to the Government of India, Foreign Department, Fort-William.

When the subject of an increased supply of cotton became one of more than usual importance, I made many inquiries regarding the cultivation of cotton in Mysore, and learned not only that several of the talooks in the northern parts of Mysore still continue to produce considerable quantities of indigenous cotton, but that the New Orleans plant, when tried on a former occasion, by order of the late commissioner, had produced a very superior staple, specially commended by the jury of the Great Exhibition of 1851. I also ascertained that the experiment of cultivating it had been abandoned solely because, when the native gin was ascertained to be unequal to the task of cleaning New Orleans cotton, Sir M. Cubbon found that it would not pay Government to maintain an establishment for purchasing and cleaning the quantity then produced. The Mysore government, on the occasion referred to, monopolised the crop obtained from the New Orleans seed at a fixed rate, and itself became the exporter or sole agent. Bearing in mind the necessity for holding out every fair inducement to the ryots to cultivate more extensively the superior plant, without deviating from the instructions of government, which prohibit all direct interference with the cultivation or sale of cotton, I felt that the practice formerly pursued was inadmissible. But having ascertained, beyond a doubt, that certain large belts of land in the northern and central talooks were highly favourable to the cotton plant, I decided upon at once initiating indirect means of assistance, which I have every hope will encourage the cultivators of Mysore, and will, by stimulating them to increased exertions, lead to the production, in 1862-63, of a cotton crop of superior quality in many parts of the province. I have, in the first place, made arrangements for obtaining from Dharwar a large supply of the best seed of the New Orleans plant, which will be sold to the ryots at cost price. *Secondly*, I have, through the superintendents of districts, notified to the ryots of cotton-growing talooks, that any waste land taken up for the cultivation of New Orleans or Egyptian plants will be given on half assessment for five years, and that gins will be provided for cleaning the same, at a fixed rate per candy, in one or more of the principal places in each talook. *Thirdly*, As it has been found that the great drawback to the cultivation in Mysore of the New Orleans or other foreign plant is the difficulty of cleaning it with the rough native machinery of this country, I have secured, as a temporary measure for the construction of saw gins, the services of a Mr W. Davis, who was for many years employed by a Bombay house as an agent for purchasing cotton, &c. in the Dharwar country.

4. *On some of the Fibrous Plants of Madras.* By Dr ALEX. HUNTER.

At a meeting of the Agri-Horticultural Society of Madras, on 15th January 1862, Dr Hunter laid on the table samples of the cleaned fibres

of the *Sansevieria cylindrica* introduced into the Society's garden by Sir Charles Trevelyan, from cuttings furnished by Sir William Hooker, which are thriving well in Madras, also fibres of the *Sansevieria zeylanica*, brought down last year by Mr Brown from the Naggery Hills, and cultivated in the garden; also cleaned fibres of the Manilla Plantain, *Musa textilis*, introduced by Lord Harris and Colonel Balfour. These all come under the class of Nars or coarse fibres for cordage and carpet-making. They are all very clean and fit for taking dyes, and possess considerable strength and gloss; but the Manilla Plantain does not yield the silky-looking fibre that is produced by the garden Plantain, *Musa paradisica* of India. This fibre is now coming into use for making carriage braid, and hearth-rugs, and is nearly as glossy as silk when it is properly cleaned. Mr Whytock of Edinburgh imports it largely for these manufactures from Bengal. Samples of the Madras Plantain fibre are being carefully prepared for the London Exhibition. Dr Hunter also laid on the table the cleaned fibres of the Yercum bark, *Calatropis gigantea*, or Bowstring hemp of India—one of the strongest fibres known. It possesses most of the qualities of flax, and can be worked with the same machinery, as the fibre splits to almost any degree of fineness with the hackle, and bears dressing and beating well. For many years this fibre was employed by the wealthy natives for making strong cloths, cambrics, and lawns worn by the Rajahs, and it is still employed for making fishing-lines, nets, gins, bow strings, and tiger-traps, on account of its strength. It does not rot readily in water, as the resinous milky-juice of the plant seems to preserve it. The silk cotton from the pod of the same plant was also exhibited. This is also becoming an article of export from India, for the manufacture of a light substitute for flannel; it has been employed by Messrs Thresher and Glenine, of London, for this and other manufactures. It works well with either silk or cotton, and is known now in commerce as Mudar silk cotton.

5. *On the Cultivation of Cinchona in Java.* By ALEXANDER FRASER, Esq., Consul at Batavia. Communicated by ALEXANDER THOMSON, Esq. of Banchoy.

The cultivation of the Cinchona plant in Java is still in a state of experiment, and requires scientific management. The conduct of the experiment has been entrusted to the care of Dr D. F. Junghun, a scientific gentleman of considerable eminence; and it is the intention of the Government to leave it under his superintendence until the cultivation shall be considered as quite successful—i.e., when the present trees are large and old enough to be barked, and the propagation no longer requires scientific supervision. Dr Junghun is assisted in the management by Dr J. E. de Vry, a chemist of some eminence, whose special duty it is to apply chemical tests from time to time to the barks of the Cinchona to ascertain their intrinsic value. To these officials is attached the following staff of overseers and labourers, whose duties, as well as those of Dr Junghun, the superintendent, are laid down in a printed memorandum of instructions. The whole present permanent annual outlay may be stated as follows:—Salary of superintendent, L.1250; salary of chemical assistant, L.1000; allowances for house rent, L.200; European overseers, L.725; native overseers and labourers, L.81. Total, L.3256.

On the 31st December 1860, the state of the Cinchona plantations in Java was as follows:—*Cinchona Calysaya*—seeds in germination, 264; young plants in the beddings and germinating sheds, 5510; plants and trees planted out, 1806. *C. lucumæfolia*—Seeds in stock, 700,000; do. in germination, 533,396; young plants in the beddings, 349,700; plants

and trees planted out, 56,686; *C. succirubra* (red Cinchona)—Young plants in the nursery shed, 13, planted out 14. *C. lancifolia* (yellow Cinchona)—Young plants in the nursery shed, 38; do. planted out, 42. Besides the above, there was then a supply in the nurseries of 1030 live cuttings of *Calisaya*, 8 do. of *succirubra*, 28 do *lancifolia*, 10 *lanceolata*. The extreme height attained by the trees at the same period (31st Dec. 1860) was *C. Calisaya*, 15 feet 8 inches English measurement; *C. lucumæfolia*, 25 feet 8 inches; *C. succirubra*, 8 feet 8 inches; *C. lancifolia*, 15 feet 2 inches; *C. lanceolata*, 13 feet. The ultimate success of the Cinchona experiment in Java would seem mainly to depend upon the question (which time only will solve), whether a supply of seed shall continue to be obtained from the *Calisaya* and *succirubra*? The other sorts contain less quinine, and it is specially maintained that the *lucumæfolia* is a species producing very little quinine.

Mr John Dawson, Alloa, sent specimens of a beetle (*Rhagium bifasciatum*), the larvæ of which are destroying the Scottish fir trees in various parts of the country. Mr Dawson also sent a specimen of a diseased state of silver fir, accompanied by the following note:—"A piece of bark of silver fir, infested by some sort of insect or fungus. The disease may be common enough, but is new here, and has made a good deal of noise in the quarter. A great many trees (silver firs alone) are affected by it, and their growth injured or destroyed. Cutting down and burning the trees are the remedial means employed." Mr W. R. M'Nab, who had examined the specimen, reported it to be a species of *Coccus*, and allied to *Coccus fagi*. The insect is of a dark red colour, oval in shape, and very small. When the contents of its body are squeezed out, a red molecular fluid appears to fill up the cavity, which in a few minutes assumes a green colour when exposed to the air.

Mr William Gorrie exhibited a flower and foliage of *Rhododendron Nuttallii*, from the greenhouse of Messrs P. Lawson & Sons, Golden Acre. The plant, which is at present in full flower, is about 8 feet high, and bears three umbellate heads, each composed of eight flowers, which measure 5 inches in width by about 5 in depth.

Dr Macgowan exhibited and presented to the Museum a Japanese broom made of bamboo and the fibres of *Chamærops Fortunei*.

SCIENTIFIC INTELLIGENCE.

ZOOLOGY.

The Economic Animals of Australia.—On the 28th of October last, Dr George Bennet delivered in Sydney a lecture on Acclimatisation, in which he gave a full account of what has been done in Europe in this department, and suggested what ought to be immediately attempted in Australia. As part of a general survey of the entire subject, he gave the following account of the native quadrupeds and birds of that country, as deserving the attention of the Acclimatisation Society which is now being formed there:—

"The attention of this Society will also be directed to the rearing and domesticating the animals of this country, and to preserve them from destruction. Among the mammals we have the kangaroo of different genera, some of enormous size, and others very diminutive, displaying a variety of colours—blue, red, grey, black, tawny, brown, mottled, &c.

The native sloth, or koala, often called by the colonists native bear (*Phascolaretus cinereus*), the wombat (*Phascolomys wombat*), the opossum (*Phalangista vulpina*), the bandicoot (*Perameles nasuta*), and others, all forming good food; and although the flesh of the kangaroo is said to be dry, I have no doubt it could be improved by being fed on succulent grasses and other suitable food; but it must be acknowledged that kangaroo-tail soup is not to be surpassed. Wombat is rarely to be met with, but when procured, its flesh is always regarded as a great treat. The lively night animal, the bandicoot, is, when cooked, only to be compared to sucking-pig in flavour. The opossum is good also, especially when curried or stewed; but the monitor lizard, or guana, if one could overcome the repugnance of its appearance, is delicate and excellent food. Among the birds we have numbers available for the table. The talegalla, or brush-turkey, is excellent, the legs being regarded as the epicure's portion, and the eggs are delicious. The large bustard, the wonga wonga, and bronze-wing pigeons, variety of ducks, curlew, teal, redbills, the megapodius, and a number of others, form excellent articles of food for the table.

"Owen says, when comparing the Australian animals with those in other parts of the world, that the *Dasyuri*, or native cats, play the part of the foxes and martens; the *Perameles*, or bandicoots, of the hedgehogs and shrews; the *Phalangers*, or flying squirrels, and the Koalas, or native bears, of the squirrels and monkeys; the wombats of the beavers, and the kangaroos of the deer tribe.

"When acclimatising animals foreign to the soil, I have before mentioned that endeavours should, by domestication, be made to preserve the mammals and birds indigenous to Australia from extermination, as they will prove valuable to us not only for food and ornament, but also as a medium of exchange with other countries; for Australia is rich in zoology. In the intertropical regions, we find, besides the Eucalypti or gum-trees, Banksias, and other trees of the southern coast, dense forests of canes, mangroves, &c. Each of these districts has a zoology peculiarly its own. For instance, the Banksias are everywhere tenanted by true honey-eating birds: the Eucalypti, or gum-trees, by the *Tricholossi*, or honey-eating parrots, and *Ptiloti*, another group of the honey-eaters; the towering fig-trees by the regent and satin-birds; the palms by the *Carpophagæ*, or fruit-eating pigeons; and the grassy plains by the ground pigeons and grass parakeets. The circumstance of the boles of the trees in this country being destitute of a thick corrugated rind or bark will doubtless account for the total absence of any member of the genus *Picus*, or woodpecker, a group of birds found in all parts of the world, with the exception of Australia and Polynesia.

"The birds represent many of the types found in Europe; yet the Australian continent possesses genera exclusively its own, many of which are nocturnal—probably more in proportion than are to be found in any other country; and a remarkable feature connected with Australian ornithology, is that of its comprising several forms endowed with the power of sustaining and enjoying life without a supply of water, that element without which most creatures languish and die. Many of the Australian birds also display an extraordinary fecundity, breeding three or four times in a season, but laying fewer eggs in the early spring,

when insect life is less developed, and a greater number later in the season, when the supply of insect food has become more abundant. One bird, the black swan, is as prolific in England as in its native country, producing four broods in one year, and proves a very profitable bird to the owner. So well has this Australian bird been acclimatised in England, that during my recent visit to that country, Mr Wolf, the celebrated animal artist, had visited Mr Gurney's residence in the country, at that gentleman's request, to make a drawing of one rearing its brood in the winter, in the midst of the snow—which drawing I had an opportunity of seeing—and it displayed the old bird, with its sooty plumaged young, nestled near the banks of an icy river, their dark plumage contrasting with the whiteness of the snow around them.

"In Australia the parrots are a numerous family, forming four large groups. The large cockatoos, such as the black cockatoos, who procure their food of grubs, &c., from the Banksias, Casuarinas, or Eucalyptuses; the Cacatuse, such as the rose and crimson-crested cockatoos, &c., feeding upon the bulbs of plants, more particularly the orchids; the honey-eating parrots (*Trichoglossi*), with their feathered tongue and no gizzard, such as the blue mountain and other parrots, subsisting only upon the nectar extracted from the blossoms of the gum-trees and other flowering trees yielding honey; and the ground and grass parroquets, as the lovely king rosehill, Adelaide parrots, lory, and others, living upon the seeds of various grasses which abound on the plains.

"In commencing the domestication of our indigenous birds, both useful and ornamental, we cannot select one more interesting than the satin bower-birds (*Ptilonorhynchus holosericeus*). They have succeeded, both in England and in this city, in being kept in a state of captivity, but have not yet built a nest, laid eggs, or reared their young; indeed, the nest and eggs of this bird is at present unknown. They are amusing, playful, and delightful mocking birds, imitating the notes of the various birds within hearing. The adult male satin bird has a glossy blue-black plumage, of satiny texture. The young males and females are of a dull green colour, which in the males becomes spotted with black, and they do not attain their full plumage for three and four, or even five years. The satin-bower birds are found in New South Wales, but the pink-necked or spotted bower-birds (*Chlamydera maculata*), whose habits are precisely similar, are found in Central, North-West, and Northern Australia. The bower constructed by these remarkable birds is perhaps the most extraordinary event in bird architecture, more especially as not being a nest for the young, but a playing place—a decorated ball-room, as it has been called—wherein the young couple flirt, and make love previous to entering upon connubial life. It is constructed with a consummate skill amusing to witness. They may be observed constructing their runs at all seasons of the year, and imitating, when at work, the notes of the various birds around. The bird is seen—from the remains of an old broom, or any twigs thrown into the aviary—to take a twig, place it firmly in the ground, slightly bent inward, the bower being left open at the top, and forming a run of an uncertain length. The ornamentation of this run is a source of constant solicitude to the birds; almost daily they make a fresh arrangement of bright-coloured feathers, shells, bleached bones, bits of coloured rags and other decorative materials,

which they bring from long distances when in a wild state,—appropriating every ornament placed within their reach when in captivity.

“The various pigeons indigenous to the colony, such as the wonga wonga, harlequin, and other bronze-wings, are all delicious for eating; the first named has the flesh white, delicate, and of surpassing flavour. The large fruit-eating pigeons of the northern districts would also form a great acquisition. They are strictly arboreal in their habits, frequenting the lofty fig-trees and feeding upon the fruit, and their flesh is excellent eating. The beauty of their plumage would also render them an acquisition to the aviary. The brilliant rifle birds (allied to the creepers), of which there are three known species, two of large size, and the no less elegant regent birds, would be a great acquisition as ornamental birds.

“It would be well to impress upon the public in this colony the necessity of preserving birds to a certain extent, so as to fulfil what nature has ordained with infinite wisdom and care—the equalisation of the races, and of obtaining a knowledge of their habits and economy, which will be found valuable to man as regards his comfort, as well as affording him security against important depredations. Many, regardless of this, are continually destroying useful animals, and thereby permit those of a noxious kind to increase. In October 1856, the territory of New South Wales suffered severely from the devastation occasioned by aphides, and all the cruciferous vegetables, as cabbages, &c., were almost entirely destroyed by them throughout the colony, when many of the soft billed birds, ruthlessly killed or driven away, might have prevented the evil. Every endeavour should therefore be made to preserve our useful and ornamental indigenous birds and animals; for if the wholesale destruction of birds and their eggs proceed in the same ratio as at present—and the Acclimatisation Societies in Europe rear and preserve them—there is no doubt we shall have to import many of our valuable birds from Europe, for among many others the emu is becoming scarce in this country. In Tasmania it is extinct in a wild state. Birds have been found of such importance in Europe to the gardener and the agriculturist, that in the French Senate in June last, M. Bonjean read a report on four petitions praying that measures might be taken to preserve birds which destroy insects hurtful to agriculture. The report is an amusing essay upon insect-eating birds, their habits, anatomy, and species of food. It treats at length of the ravages of insects, and the importance to man of the objects they destroy. France, as well as other countries, is infested with thousands of species of insects, nearly all of which prey on what should serve the purposes of man. The first section of the report is headed, ‘Importance of Birds to Agriculture.’ It states that the wire-worm consumed L.160,000 worth of corn in one department alone, and was the cause of the three deficient harvests which preceded 1856. Out of 504 grains of colza gathered at hazard at Versailles, all but 296 had been rendered worthless by insects. The reduction of yield in oil was 32·8 per cent. In Germany, according to Latreille, the larva of a species of moth (*Phalena-monacha*) consumed whole forests. In Eastern Prussia, three years ago, more than 24,000,000 cubic metres of fir had to be cut down because the trees were attacked by insects. Man is unable to cope with these destroyers of the produce of his labour. His eye is too dull to perceive, and his hand too slow to catch them.

Without the aid of birds he would be vanquished in the struggle. The commission excludes birds of prey, such as magpies, ravens, &c., with the exception of buzzards and rooks, from the benefit of its protection, because the buzzard consumes about 6000 mice yearly, and the rook an incalculable amount of white worms. Sparrows are restored, and their usefulness shown by reference to the fact, that when their destruction was attempted in Hungary winged insects increased so rapidly that rewards for the destruction of sparrows were suppressed, and given for bringing them back. Frederick the Great ordered the destruction of sparrows because they ate his cherries; but in two years' time he found his cherries and all other fruits consumed by caterpillars. In a sparrow's nest on a terrace in the Rue Vivienne were found the remains of 700 cockchafers. Owls and birds of that class, which agricultural ignorance pursues as birds of evil omen, ought to be welcomed. They are ten times more useful than the best cats, and not dangerous to the larder. The martens that were killed were found to have in their stomachs the remains of 543 insects. It recommended a prohibition of bird-nesting and destruction of eggs or young birds.

"The larger and typical gallinaceous birds are entirely wanting in Australia, being represented by birds whose mode of incubation indicates an inferiority of type, as the *Megapodius* (*Megapodius tumulus*), *Leipoa* or mallee bird of the Murray (*Leipoa ocellata*), and the *Talegalla* or Brush turkey (*Talegalla Lathamii*), all considered good eating, and by many considered, when young, and in the perfection of season, preferable to our European game. It is to the last bird, the brush-turkey, I shall now direct attention; it forms part of a great family of birds inhabiting Australia, New Guinea, the Celebes, and the Philippine Islands, and whose habits and economy differ from every other group of birds which now exist in the world. In their structure they are nearly allied to the gallinaceous birds. They do not incubate their eggs, and are consequently regarded by ornithologists as the lowest representatives of their class. The brush-turkey is now becoming acclimatised in England; the young are reared in the Zoological Gardens of London, and I hope that we shall soon see it forming its mound, and the young birds emerging from it, in or near Sydney; for, as I have before remarked, they are an excellent article of food, and are well worth rearing for the table. A very interesting account is given in the proceedings of the Zoological Society of London of the incubation of these interesting birds, and the production of the young; it also proves how easily they can be domesticated, and from their tameness, and the interest attached to them from their peculiar habits, may induce us to lose no time in making an early trial of them here. The pair of *talegallas* during the spring and summer of 1860 formed a large hatching mound, composed of leaves, grass, earth, and other material. Within this heap of warm fermenting gatherings the female deposited twenty eggs, with the small end downwards. The *time of laying*, the *interval of time between each egg*, and the *period of incubation*, are at present unknown.

"In the *talegalla* we seem to approach the reptilian character, not only in the form and general appearance of the eggs, but in the manner in which they are deposited, and the absence of care bestowed upon the young. I believe, with this exception, all birds feed or provide for their young,

while, on the other hand, I am not aware any reptile is known to do so. and that all the reptiles that lay eggs leave them to hatch, and the young to provide for themselves,—their young, as in the talegalla, coming forth in a very perfect and well-developed condition, and being enabled to seek and obtain their food without the aid of the parents. It is for this reason, as I have before remarked, the family Megapodidæ are placed in the lowest form of birds.

“Another remarkable bird, native of New South Wales, is the *Menura superba*, ‘lyre bird, or pheasant of the colonists.’ For a long time this bird divided ornithologists as to the situation it should occupy in the natural system, and for upwards of fifty years from its discovery but little was known respecting its habits and economy. Having only external structure to guide them, it was placed amongst the gallinaceous birds. Notwithstanding its great size and extraordinary form of tail, in every other point it differs from the Gallinaceæ. It forms one of the Insectorios or perching birds, and by one ornithologist, from its covered nest, it was placed among the wrens, but it is more correctly classed among the thrushes. The young are helpless and blind when hatched. It will be necessary to preserve these birds from extermination, especially the talegalla and that family; for they are now becoming scarce, and from the present wholesale destruction of the eggs and birds, they will soon be numbered with the extinct birds, as the Philip Island parrot, the gigantic New Zealand rail (*Notornis Mantelli*), and many others.

As fish is so necessary an article of food for all classes, being digestible and nourishing, an Acclimatisation Society should direct their attention to the introduction of new and valuable kinds, as well as preserving and increasing those already existing in our rivers, bays, and salt-water creeks—for fish fall an easier prey to man than the beasts and birds.

Artificial ponds, for the maintenance of fish, is a very early invention, and was even known among the ancient Egyptians. Vivaria among the ancients are mentioned by Columella, Varro, and Pliny, and fish were brought from a great distance; and an extraordinary fact is mentioned by Columella, that rivers and lakes were turned into natural vivaria, by carrying to, and depositing therein, not fish only, but the spawn of all such species as, though born at sea, are in the habit of penetrating some way up estuaries or streams. He speaks of the perfect success of the experiment in several rivers. Various kinds of fish have been and are still being introduced, by preserving the ova, into different waters of England and on the Continent, in localities where previously they had no existence; they have succeeded well, and where congenial food is plentiful, the result is perfectly satisfactory.

The Australian blacks on the coast are expert fishermen; and Mr Edward Mill, who possesses much information on the subject, informs me that when the beautiful waratah or native tulip blooms, it is a well-known sign to these children of nature that the sole (a rare fish to be seen in the Sydney market, but of excellent flavour) is very abundant on the sand banks about Botany Bay and in the vicinity of Cook's River, where they may be captured at early dawn, before the ripple comes upon the water. According also to the flowering season of other trees and shrubs, the blacks know the season when the mullet, schnapper, Port Jackson shark (*Cestracion*), or other fish, are plentiful in the bays or harbours of the coast.

One of the first acts of the Acclimatisation Society, when established, would be to introduce that fine and delicious fish of the perch tribe, called the Murray River Cod, and which has been introduced with perfect success in the Yarra, and lately in Lake George, by the honourable the Speaker, Mr Murray, in 1848. Suitable localities could also be found in the Nepean, Hawkesbury, and such rivers and lakes in the colony where it does not at present exist.

Sharks and other fish might be procured for their oils, both for economical and medicinal purposes,—and for the latter, might equal the cod liver oil, now imported in such large quantities. At present the Dugong oil is used as a substitute, an animal belonging to the mammalia, and is said to be beneficial to invalids afflicted with strumous disease; but its virtue, except as a nutritious diet, is very questionable. It is a curious fact, that while we regard this and cod liver oil as new remedies in pulmonary diseases, that in 1790, Valliant, in his travels in Africa says:—“At the Cape the fat of the hippopotamus is thought so wholesome, that they affirm if it is taken in regular portions, it will radically cure all disorders of the breast.”

Sir Emerson Tennent, in his interesting volume on Ceylon, made mention of musical sounds said to arise from some of the lakes in the island. In his later published work, “Sketches of the Natural History of Ceylon,” &c., where he has brought together his zoological and botanical observations, he again refers to the very curious subject of sounds given out by the mollusca, stating that the Indians believed the sounds alluded to were produced by the animal of a shell and not by any fish, and that those sent to search for the shells brought him specimens of a *Littorina* and *Cerithium*, the latter being *C. palustre*. Sir Emerson Tennent states also that similar sounds are heard at some places on the western coast of India, especially in the harbour of Bombay. At Caldera, in Chili, musical cadences are stated to issue from the sea near the landing place, and the same have been observed at Pascagonda, in the state of Mississippi, and in another river on the northern shore of the Gulf of Mexico. In a letter received lately from J. Hepburn, Esq., San Francisco, who has been travelling in Columbia and Vancouver's Island, the following observation occurs:—“A fact that I discovered, which greatly interested me, is the existence in Vancouver's Island of a singing fish (at least shell-fish), such as Sir E. Tennent met with in Ceylon. Some of my fishing friends, who had never heard of Sir E. Tennent's book, told me that at a certain arm of the sea running out of Victoria Harbour, they always heard a noise which they compared to the sound of a Chinese kite when flying, a sound well known to all inhabitants of San Francisco, and which is produced by fixing pieces of metal to the kite's tail. I went there and heard it several times, clearly proceeding from the water. The Indians are well acquainted with the noise, and say it proceeds from a stone-fish (shell-fish), and promised to get me some, which, however, they had not done up to the time of my leaving. When I return I will inquire further into it, though I do not know that I can establish anything further than that such an animal exists at the place where the sound is always heard. It is not likely that the Indians and the Cingalese should both attribute the sound to a similar cause, unless there is some foundation for it.”

There is no doubt whatever that sounds are produced; and we trust that by calling attention to the facts as stated by Sir E. Tennent and Mr Hepburn, attention will be directed to the elucidation of the cause.

MISCELLANEOUS.

River Niger.—The Niger receives in its course numerous tributaries, flowing through regions abounding in interesting and valuable productions. It is affirmed that the tributaries, entering it within a distance of two leagues from where the river on which Timbuctoo is placed makes its junction, amount to thirty. For two hundred miles above this point, and below it to the neighbourhood of Rabba, the river is navigable for the largest canoes. Rabba, which is about 280 miles from our new possession, Lagos, across the Yoruba country, is also only eleven days' journey from Kano. Kano is the most southern and western large emporium for the European goods brought overland on camels above 2000 miles from Morocco and Tripoli. That part of the interior of Africa has still a large population, although much wasted by slave-trade wars; as not only have the Morocco and Tripoli caravans to be supplied with slaves for much of the value of the goods they have brought, but thousands are also sent through Rabba, for the foreign slave-trade of Dahomey, and for the supply of the native markets on the coast. The African-Aid Society has represented to the Government the necessity of stopping that horrible trade, and stimulating the industrial development of these rich districts, by establishing a consul at Rabba, with a gunboat at his command there, to give him additional weight and influence in arranging all disputes amongst the natives, and to enable him effectually to prohibit the slave-trade of Dahomey. From Egga, below Rabba, along the whole coast of the Niger upward, and even to Dahomey, that valuable shrub or tree, which produces the Shea butter, abounds. There can be no doubt that, if a proper stimulus be given, and if the natives felt that the establishments formed among them by Europeans at Egga and Rabba were permanent ones, the entire of that rich caravan trade, from Morocco and Tripoli to Kooka and Kano (and those caravans are often of from 2000 to 3000 camels each), would be diverted to the Niger route, by which goods from Europe may be conveyed at one-tenth of the cost by caravans from Tripoli. And it is almost equally certain, that, within a few years, Shea butter alone (which now costs about L.6 to L.8 a ton near Egga, and would fetch—for any quantity—in England L.40 a ton) would pay, every year, for hundreds of thousands of pounds' worth of Birmingham and Manchester goods. And when to Shea butter we add palm-oil, ground-nuts for oil, copal and other gums, ivory, ebony, indigo, other dyes, and dye-woods, cotton, coffee, chili pepper, ginger, arrowroot, wax, honey, India-rubber, saltpetre, antimony, gold, silver, copper, and other valuable commodities, it must be granted that there is a real Hesperides in the fields of the great Mississippi of Western Africa—the River Niger.—*Church Mis. Gleaner*, February 1862.

PUBLICATIONS RECEIVED.

1. Proceedings of the Literary and Philosophical Society of Manchester for February, March, and April 1862.—*From the Society.*
2. Journal of the Chemical Society for February, March, April, May, and June 1862.—*From the Society.*
3. The Canadian Naturalist and Geologist for February 1862.—*From the Editors.*
4. Proceedings of the Academy of Natural Sciences of Philadelphia. Pp. 145-556.—*From the Academy.*
5. Journal of the Academy of Natural Sciences of Philadelphia. New Series. Vol. V. Part I.—*From the Academy.*
6. Bulletin de l'Academie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Nos. 1-4. Bruxelles, 1862.—*From the Academy.*
7. Volcanoes—the Character of their Phenomena, their Share in the Structure and Composition of the Surface of the Globe, and their Relation to its Internal Forces. By G. POULETT SCROPE, M.P., F.R.S. 1862.—*From the Publishers.*
8. Project of a New System of Arithmetic, Weight, Measure, and Coins, proposed to be called the Zonal System. By JOHN W. MYSTROM, C.E. Philadelphia, 1862.—*From the Author.*
9. Annual Report of the Geological Survey of India. 1860-61.—*From Professor Oldham.*
10. Memoirs of the Geological Society of India. Vol. III.—*From Professor Oldham.*
11. Journal of the Asiatic Society of Bengal. No. 4. for 1861.—*From the Secretaries.*
12. Remarks on the Grounds of Faith, suggested by Mr Pattison's Essay on the Tendencies of Religious Thought. By C. GOOCH, M.A., Fellow of St Mary Magdalen College.—*From the Author.*
13. The Colony of New South Wales ; its Agricultural, Pastoral, and Mining Capabilities. Compiled by the Commissioners of the Colonial Government. With a Map of the Colony.—*From the Commissioners.*
14. On the Various Contrivances by which British and Foreign Orchids are Fertilised by Insects, and on the Good Effects of Inter-crossing. By CHARLES DARWIN, M.A., F.R.S.—*From the Publisher.*
15. The Student's Manual of Geology. By J. BEETE JUKES, M.A., F.R.S. New Edition. 1862.—*From the Publishers.*

THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

On the Excess of Water in the Region of the Earth about New Zealand; its Causes and its Effects. By JAMES YATES, M.A., Fellow of the Royal, Linnean, and Geological Societies, Member of the Manchester Geological Society.

§ 1. *Question stated.*

In the earlier part of the last century, an idea prevailed that there must be a great continent about the South Pole, capable of balancing the large tract of dry land which surrounds the North Pole. James Cook and other navigators were sent on voyages of discovery to ascertain this fact; but nothing of the kind was brought to light, and no land has ever been discovered in sufficient mass to correspond with the great extent of land in the northern hemisphere. I propose to inquire whether the equipoise may not be found in another way, namely, under the surface of the earth. There is reason to believe that one half of the moon is heavier than the other half. In like manner, I think it probable that the half of the solid earth to which New Zealand belongs is heavier than the opposite hemisphere; and it will be my endeavour to explain the grounds of this supposition, and to follow it into its consequences.

§ 2. *Distinction between Land and Water Hemispheres.*

Geographers were formerly satisfied with the observation, that the ocean is vastly more extensive about the South than about the North Pole. Recently they have stated the fact with much

greater accuracy. Berghaus, in his *Physical Atlas*,* exhibits the earth divided into two hemispheres on this principle. One, called the Land Hemisphere, contains nearly all the dry land, whilst the other, called the Water Hemisphere, consists almost entirely of water. The centre of the aqueous portion is marked by the meridian of 170° west longitude from Paris, where it intersects the parallel of 40° south latitude.

§ 3. *Shown on a Terrestrial Globe.*

The same fact may be easily rendered manifest by taking a terrestrial globe, and turning it so that the point just described may be in its zenith. It will then be seen that the hemisphere placed above the wooden horizon is almost entirely water. It will contain no portion of "the four quarters of the globe," except the extremities of South America, and of the Malay Peninsula. New Holland occupies a large space, and the ocean is studded with innumerable islands, the largest of which are Japan, New Guinea, Sumatra, Java, Borneo, Celebes, and New Zealand. We also observe the borders of land of unknown extent in the direction of the South Pole, called South Victoria, Enderby's Land, and by other names.

§ 4. *Height of Mountains in Land and Water Hemispheres.*

The mountains rise to a far greater elevation above the surrounding seas in the Land or European, than in the Water or New Zealand hemisphere. This will appear from the subjoined tables. The first contains the heights of ten conspicuous mountains in the land hemisphere, chosen as much as possible from remote parts of that hemisphere; the second includes ten mountains, chosen in like manner from remote parts of the water hemisphere, and equally remarkable for their superior elevation. The two columns being added up, the amounts show at a glance the comparative average eleva-

* *Physikalischer Atlas*, Gotha, 1ter Band, 3te Abtheilung, "Erdkarte zur Übersicht der Vertheilung des starren und flüssigen." A similar map on a much smaller scale may be seen in Petermann's *Atlas*, Nos. 1 and 2; Stieler's *Hand-Atlas*, No. 8; Keith Johnston's *School Physical Atlas*, No. 2; *The Earth and Man*, by Guyot, London (Parker), 1857, p. 14; Lyell's "*Principles of Geology*," 1853, p. 110.

tion of the two sets of mountains—viz., 5524 metres for the one, and 3604 for the other.

I. Mountains in the Land Hemisphere.

	Metres.
Deodunga, Himalaya, . . .	8748
Acancagua, Chili, . . .	7314
Kilimanjaro, Equatorial Africa, . . .	6095
Elbrouz, Caucasus, . . .	5646
Popocatepetl, Mexico, . . .	5400
Mount St Elias, Rocky Mountains, . . .	5113
Mont Blanc, Europe, . . .	4810
Kliutschewsk, Kamtschatka, . . .	4804
Teneriffe, Atlantic Ocean, . . .	3710
Wrangell's Volcano, Coppermine River, . . .	3600
	55,240

II. Mountains in the Water Hemisphere.

	Metres.
Singalang, Sumatra, . . .	4570
Mowna Kia, Sandwich Islands, . . .	4252
Mount Terror, South Victoria, . . .	4232
Tobreonow, Otaheite, . . .	3725
Semeru Gunong, Java, . . .	3720
Fusi-no-yama, Japan, . . .	3710
Alaid, Kurile Islands, . . .	3648
Mount Ambotismene, Madagascar, . . .	3507
Mount Egmont, New Zealand, . . .	2700
Mount Kosciusko, Australia, . . .	1976
	36,040

Difference in average height . . . 19200

§ 5. *Comparative Areas of Land and Water.*

In addition to the two principal facts which I have now stated, viz., the great excess of water in the region around New Zealand, and the greater elevation of the mountains in the opposite hemisphere, geographers have also endeavoured to make an accurate comparison between the extent of the earth's surface covered with water, and the surface which is left dry.

Professor Rigaud of Oxford made the computation in the following manner:—He obtained from a map and globe-maker in London a set of the gores which are used to make a terrestrial globe. He cut out all the continents and islands,

and weighed them. He then weighed in like manner all the waters, having taken care that the two sets of papers were equally free from moisture.* The weights of the two parcels gave the relative quantities of land and water, which appeared to be in the proportion of 100 to 270. Professor Link of Berlin, on the other hand, estimates the whole surface of the earth at 9,282,060 square German miles, and the dry land at 2,380,000.† According to this statement, the dry land is to the water as 100 to 289. Humboldt makes the proportion as 100 to 280.‡

Soon after the appearance of Rigaud's memoir, Mr William Hughes, an eminent Professor of Geography in London, pursued the investigation in a totally independent manner. He divided the surface of the terraqueous globe into 180 zones, each covering one degree of latitude, and he constructed a table, which showed the area of each zone in succession from the equator to the poles. He then obtained copies of the largest and best maps, and, taking each zone separately, he measured with extreme care the land and water. The result in English square miles was as follows:—

Land, 51,448,594·743 ; Water, 145,413,160·256.

“The close agreement of these calculations,” says Mr Hughes, “with the results arrived at by Professor Rigaud, through an entirely different mode of investigation, affords a strong confirmation of their general correctness.”§

The last published computation is 51 to 146, equivalent to 100 to 286, in which the author, Sir John Herschel, has provided for “the recently discovered tracts of land in the vicinity of the poles.”|| In 1838, Berghaus gave the entire surface of the ocean = 6,636,800 square German miles, and the land = 2,423,700. This would be in the proportion of 100 to 273.¶

* Transactions of Cambridge Philosophical Society, vol. vi. part 2, A.D. 1837, p. 297.

† *Physikalische Erdbeschreibung*, I. (Berlin, 1826), p. 116.

‡ *Cosmos*, Mrs Sabine's Translation, I. (London, 1846), p. 279.

§ Hughes's *Principles of Mathematical Geography* (London, 1843), pp. 125–128.

|| *Physical Geography* (London, 1861), p. 19.

¶ *Physikalischer Atlas*, &c.

But in his *Grundriss der Geographie*, Breslau, 1843 (p. 119), he assigns $261 : 739 = 100 : 283$, as the result of the most careful inquiries; and in a still more recent work, *Was man von der Erde weiss* (Berlin, 1856), he informs us, that at the suggestion of Humboldt he had examined the subject again, and in consequence of Sir James Ross's discoveries within the Antarctic Circle, and of the discovery of islands to the north of America, he had fixed the proportion at $281 : 719$, taking 20 from the sea to give it to the land. The result of this is land 100, water 256. Thus, if the land be estimated at 100, the water will certainly be somewhere between 256, the lowest estimate, and 289, the highest; and it will be of use to observe, that these numbers are respectively the squares of 16 and 17, 100 being the square of 10.

§ 6. *Answers to the question by Forster, Peterman, Herschel.*

As the determination of the proportion of land to water was the chief object of Cook's second voyage, it necessarily engaged the attention of his companions, and especially of the celebrated John Reinhold Forster, who was appointed to the office of Naturalist to the expedition. Accordingly, in his volume of "Observations made during a Voyage round the World" (London, 1778), chap. ii. sec. iii. p. 68, he states that they had not been able to discover land "sufficient to counterpoise the lands of the Northern Hemisphere;" and adds, "I am therefore apt to suspect that nature has provided against this defect by placing, perhaps at the bottom of the Southern Ocean, such bodies as, by their specific weight, will compensate the deficiency of lands; if this system of the wanted counterpoise be at all necessary. But there may, perhaps, be other methods to obviate this defect, of which our narrow knowledge and experience have not yet informed us."

Forster's idea of a counterpoise at the bottom of the Southern Ocean does not appear to have attracted the least notice. On the contrary, those who have attempted a solution of the problem seem to have directed their attention entirely to the opposite hemisphere, and have had recourse to the action of internal forces, which are supposed to have raised the continents above the sea-level in the Land Hemisphere. Mr

Peterman says, in his "Atlas of Physical Geography" (Orr and Co., Amen Corner, 1850), "The preponderance of land in the northern hemisphere indicates the superior intensity of the causes of elevation in northern latitudes at a remote geological epoch."

Sir John Herschel gives the following solution, which appears to be not essentially different from Peterman's, except that "tumefaction" may denote geological energy in action at the present time. "The fact of the existence of two hemispheres," the one chiefly land, the other almost entirely water, in the words of this author, "proves the force by which the continents are sustained to be one of *tumefaction*, inasmuch as it indicates a situation of the centre of gravity of the total mass of the earth somewhat eccentric relatively to that of the general figure of the external surface, the eccentricity lying in the direction of our antipodes, and is therefore a proof of the comparative lightness of the materials of the terrestrial hemisphere."*

§ 7. "*Tumefaction*" Theory insufficient.

It appears to me that this theory, though partly true, is not entirely supported by facts, and does not reach the requirements of the case. Confining ourselves to Europe, we know that, if the coast of Sweden has been gradually rising by the swelling of substances beneath it, the coasts of Holland, Belgium, the north of France, and the opposite coasts of England, have been sinking. The Temple of Serapis at Puzzuoli is a well-known instance of the land rising and falling within a brief space of time. Thus the intumescence of some regions is balanced by the subsidence of others. But another mass of facts is furnished by Herschel himself in answer to his own theory. The passage which I have quoted is near the beginning of his highly valuable and interesting work, and at the end of the same volume he gives a "Table of the Heights of Mountains," classing them according to the usual great divisions of the earth, and distinguishing those which are now

* Physical Geography (Edinburgh, 1861), § 13. See also § 132, where this author supposes a "general substratum of liquified matter" to support the solid crust of the earth.

active volcanoes. From this list we learn that out of 465 mountains in the Land Hemisphere, 62 are volcanic, being rather more than one-seventh; whereas, in the Water Hemisphere, 66 in 109, or more than one-half, are active volcanoes. It is also important to observe, and Sir John Herschel bears witness to the fact (p. 254), that earthquakes are no less frequent and violent in the Water than in the Land Hemisphere. If, then, earthquakes and volcanoes are evidences of the "superior intensity of the causes of elevation," this cannot be the true explanation, for they abound in the one hemisphere, at least, as much as in the other. The only visible difference between the two hemispheres is, that the mountains are much higher, and the tracts of dry ground much more extended in the Land than in the Water Hemisphere. I must not be supposed to deny the existence of "tumefaction," or its great importance in explaining the present configuration of the earth. I shall hereafter (§ 20) have occasion to show when and how it plays its part. But at present I wish rather to take the existing facts, so far as they are known to us, and to use them as the basis of our reasoning. Not only are the ocean and the atmosphere subject to continual fluctuation, but the external covering of the earth is, to a certain extent, pliant and flexible. Mr Babbage has shown that its expansion by heat may sensibly change its elevation.* Also the portions now submerged cannot but have been dry ground in former geological epochs; otherwise it is impossible to account for the phenomena of the sedimentary rocks. Elevations and depressions have always been going on, and must be attributed to the agency of expansive forces, which act from below upwards, expel great quantities of vapour, and leave behind hollows and cavities filled with water.

§ 8. *Solution attempted by Aid of a Diagram.*

To assist in arriving at a true solution of the problem before us, I shall now refer to a diagram constructed, as all diagrams are, to aid our conceptions and reasonings.

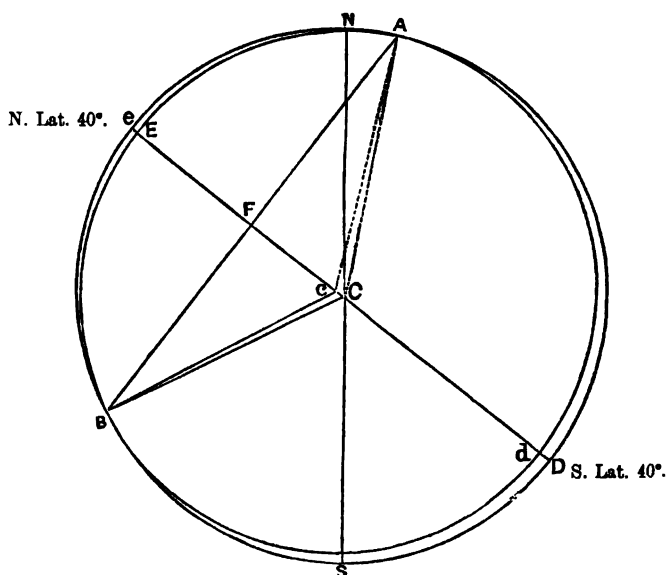
This diagram must be supposed to represent a section of the

* Proceedings of the Geological Society, vol. ii., March 1834, pp. 74-76, and Ninth Bridgewater Treatise, pp. 209-216; Lyell, p. 562.

earth through the meridian of New Zealand, and to show the ocean partly encompassing the earth, the atmosphere surrounding the whole, but not represented. The letters N and S denote the North and South Poles at the extremities of the axis of the earth. The point C, which bisects the axis, is assumed to be the geometrical centre of the surrounding atmosphere, it being pre-supposed that both the atmosphere and the earth are spherical. It is not attempted to represent the earth's ellipticity, because, in the first place, its amount is not known; secondly, if it were known, it is too small to be represented on a diagram; and, thirdly, no regard need be paid to it with a view to the correctness of the conclusions at which I aim in the following memoir.

Ideal Section of the Earth in the Meridian of New Zealand.

The space ADB, is the ocean; the space on the other side of the chord AB, is the dry land, drawn from c as a centre, with radius cB.



NCS = Axis of rotation.

C = Mathematical centre of the atmosphere and of the ocean, and centre of gravity of the atmosphere and terraqueous globe.

c = Mathematical centre of the solid earth.

Table of Dimensions, with reference to the Ideal Section of the Terraqueous Globe.

1 English foot = .30479449 metre.

AEBD, circumference of the terraqueous globe, 360° , 4000 myriamètres, or 40,000 kilometres, or 40,000,000 metres = 21,600 geographical miles of 60 to a degree = 21,600 minutes of a degree $\therefore$ 1 geographical mile, or minute of a degree = 1852 metres nearly.

DE, diameter of the same, $\frac{40,000,000}{3.14159265} = 12,732,396$ metres.

DC, AC, EC, semi-diameter or radius of the same, = 6,366,198 metres.

Dd, greatest general depth of the ocean, being about 1920 metres, or $\frac{1}{6631}$ of DE, the earth's diameter (see below, § 13).

Ee, greatest general elevation of continents above the sea-level, being about 600 metres, or $\frac{1}{21,220}$ of DE, the earth's diameter (see below, §§ 14–17).

Arc AEB, being 125° nearly, = 7500 geographical miles, or about 1380 myriamètres (§§ 9–14).

Arc AE, being $62^\circ 30'$ nearly, = 3750 geographical miles, or about 6900 kilometres.

Cc, eccentricity of the earth's centre of gravity, 1260 metres (§ 16).

Diameter DE, divided at the point F in the proportion of 109 to 40, or of 9,314,303 metres to 3,418,093 metres (§ 15).

Besides the axis another diameter bisects the circle, being drawn from the point D, which is 40° from the equator; in other words, it is drawn from the point where the meridian of New Zealand intersects the parallel of 40° south latitude. I believe that, in fixing this point, Berghaus had the advice and co-operation of two of his fellow-citizens who were indisputably pre-eminent as physical geographers, Alexander von Humboldt and Karl Ritter.

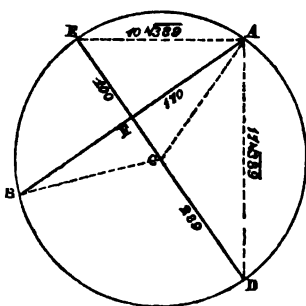
Having chosen this diameter, DE, in conformity with Berghaus's computation, I suppose the ocean to extend to an equal distance on every side of it, and to thin off towards the chord AB, corresponding to the circle on the earth's surface, which would be the boundary of the ocean, if it were all collected

into one uniform mass of water, instead of being ramified and distributed into oceans, seas, bays, and straits.*

§. 9. *Determination of the points A, B, in the Diagram.*

The determination of this chord AB is important, and may be made with sufficient accuracy for the purpose of the present inquiry, on the grounds that I have already assumed in treating of the relative quantities of dry land and water.

Reasoning from the facts, that the surface of a sphere is equal to the surface of a hollow cylinder whose height and diameter are equal to the diameter of the sphere, and that the surface of any segment or zone of the sphere, intercepted between parallels perpendicular to the axis, is equal to the surface of the cylinder intercepted between the same parallels,†



we may divide the diameter DE into two parts in the proportion of 100 to 289,256, or any intermediate number, and through the point of division F draw a perpendicular cutting the circle in the points A, B. The segment of the terraqueous globe, corresponding to AEB, will then be to the other segment in the proportion of EF

to FD.

Or we may compute as follows :—

* According to some writers on physical geography, the centres of the land and water hemispheres are much nearer to the poles than 40° . Professor Ansted (*Manual of Geographical Science*, London, 1852, p. 216) says, "If an observer were stationed vertically above a point in England not far from the Land's End in Cornwall, and could thence see one-half of the globe, he would have before him almost all the land, while, on the other side, would be scarcely anything but a few islands and a portion of Australia and Patagonia visible above the water." This opinion is supported by Sir John Herschel, "*Phys. Geography*," p. 14. Hence I am inclined to think that the points D, E, may be placed nearer the poles than I have supposed. If, instead of 40° , we place them at 45° , we may be as near the truth, and we may possibly obtain some facilities for our reasonings and computations. The general results cannot be affected by so small a difference.

† Hutton's *Mensuration* (Newcastle-on-Tyne, 1770), p. 193.

First, taking the proportion of 100 to 289.

To find chord AE.

$$\begin{aligned} AE^2 &= EF^2 + FA^2. \text{ Euclid, B. I., 47.} \\ &= EF^2 + EF \times FD. \text{ Euclid, B. III., 35.} \\ &= (100)^2 + 100 \times 289. \\ &= 100 \times 389 \end{aligned}$$

$$\therefore AE = 10 \sqrt{389}.$$

In same way, $AD = 17 \sqrt{389} \therefore AE : AD = 10 : 17.$

$$\begin{aligned} \text{Again, arc AE : arc AD} &= \angle \cdot ACE : \angle \cdot ACD. \text{ Euc. VI. 33.} \\ &= \angle \cdot ADE : \angle \cdot AED. \text{ Euc. III. 20.} \end{aligned}$$

To find $\angle \cdot AED$.

$$\begin{aligned} \text{Tan. } \angle AED &= \frac{170}{100} = 1.7 \\ \therefore \angle AED &= 59^\circ 32' \text{ nearly.} \\ &= 59 \frac{8}{15} \end{aligned}$$

$$\therefore \angle ADE = 90^\circ - AED = 30 \frac{7}{15}$$

$$\begin{aligned} \therefore \angle ADE : \angle \cdot AED &= 30 \frac{7}{15} : 59 \frac{8}{15} \\ &= 457 : 893 \end{aligned}$$

$$\begin{aligned} \therefore \text{Arc AE : arc AD} &= 457 : 893 \\ &= 10 \frac{8930}{457} \\ &= 10 : 19 \frac{247}{457} \\ &= 19 \frac{1}{2} \text{ nearly.} \end{aligned}$$

$$\angle ACE = 2 \cdot \angle ADE$$

$$\dots = 60 \frac{14}{15} = 60^\circ 56' \text{ nearly.}$$

$$\begin{aligned} \therefore \text{Arc AEB subtends an angle} &= 121^\circ 52' \text{ nearly,} \\ \text{and arc ADB} \dots &= 360^\circ - (121^\circ 52') \\ \dots \dots \dots &= 238^\circ 8'. \end{aligned}$$

Secondly, taking the proportion of 100 to 256.

$$\begin{aligned} \text{Let EF} &= 100, \text{ and FD} = 256, \\ \text{Then AF} &= 160, \end{aligned}$$

$$\text{And tan. } \angle AEF = \frac{160}{100}$$

$$\dots \dots = 1.6$$

$$\begin{aligned} \therefore \angle AED &= 58^\circ \text{ nearly.} \\ (58^\circ \text{ is a little in excess).} \end{aligned}$$

$$\begin{aligned}
\therefore \angle ADE : AED &= 32 : 58 \\
\dots \quad \dots &= 16 : 29 \\
\therefore \text{Arc AE} : \text{arc AD} &= 16 : 29 \\
\dots \quad \dots &= 10 : \frac{290}{16} \\
\dots \quad \dots &= 10 : 18\frac{1}{8} \\
\text{Hence } \angle ACE &= 2 \angle ADE \\
\dots \quad \dots &= 64^\circ \text{ nearly.} \\
\therefore \text{Arc AEB subtends an angle} &= 128^\circ \text{ nearly,} \\
\text{and arc ADB} \quad \dots &= 360^\circ - 128^\circ \\
\dots \quad \dots &= 232^\circ.
\end{aligned}$$

Having taken the two extreme cases of the greatest excess of water and the least, so far as they have been proved by observation, we may safely assume, as the amount of our arc 125° , since this is as nearly as possible the middle between the two extremes. If we regard this as the diameter of the land hemisphere at the level of the sea, we cannot be far wrong, and we shall then be able to find the corresponding curve of the earth's surface in geographical miles and myriamètres by the following proportions:—

Geographical miles.

$$360^\circ : 125^\circ :: 21,600 : 7500 \text{ geographical miles.}$$

Myriamètres.

$$360^\circ : 125^\circ :: 4,000 : 1388\frac{1}{2} \text{ myriamètres.}$$

§ 10. *Question may be solved in two ways.*

If we endeavour to show why there is so great an excess of water in the south-eastern hemisphere, we may account for the fact in two ways. Either we may suppose that the solid earth is lower in all that portion; in other words, that a large mass is wanting to complete its sphericity, and that the space is occupied by water instead of earth; or, *secondly*, we may suppose that the submerged hemisphere is heavier than the other, and attracts the water by its greater density and specific gravity. The first supposition is at variance with all the ideas hitherto received, and does not harmonise with what we know of the form of the other planets. I therefore think it

unnecessary to dwell upon this hypothesis, and shall confine myself to the other.

§ 11. *Supposed greater Weight of the Land Hemisphere.*

The greater weight of the New Zealand hemisphere may arise from two causes; it may contain a greater proportion of igneous rocks and mineral veins, and the opposite hemisphere may contain a greater proportion of cavities filled with water.

From all we know of the crust of the earth, it is certain that its constituent parts are mingled together, and interposed without any constant rule or law as to their specific gravities. We may therefore regard it as indisputable, that the two hemispheres are of unequal weight. The only question is, which preponderates over the other, where the limits of the heavier portions are to be found, and what effects may be ascribed to them. It appears to me, therefore, that there cannot be the slightest objection to the assumption, that there is a greater abundance of mineral veins in that part of the earth which lies beneath New Zealand and the islands and seas surrounding it. Also beds of ironstone may be supposed to exist in superabundance throughout the same region, together with basaltic rocks and others of high specific gravity.*

On the other hand, the Land, or European hemisphere, besides the inferior specific gravity of its mineral constituents, including more especially beds of coal, may abound in depressions, or in cavities filled with water. It is generally supposed that the waters of the Atlantic occupy a great valley, which divides the Old from the New World, and extends from pole to pole. Its lowest depths have never been reached by soundings. According to Captain Maury,† “the greatest depths at which the bottom of the sea has been reached with the plummet are in the North Atlantic Ocean.” But besides valleys, or hollows on the surface, we have reason to believe that this hemisphere contains numerous and extensive cavities beneath the surface. On the shore of one of the Ionian Isles, Cephalonia, is a considerable cascade of sea-water,

* See list of “Specific Gravities of Rocks,” and deductions therefrom, in De la Beche’s *Geological Researches*, pp. 74–78.

† *Physical Geography of the Sea*, § 701.

which, after turning a mill, pours itself in a constant stream into the bowels of the earth.* Springs of fresh water, on the other hand, rise from the bottom of the Mediterranean Sea in many places. The whole coast, from Cette in Languedoc to Ruad in Syria, may be said to be studded with these so-called "occhi."† In the Caribbean Sea, so great a volume of fresh water rises to the surface, that ships go there for a supply, and the manati (*Trichechus manatus*), an amphibious fresh-water mammal, frequents the same spot. By land, we have the mud-volcanoes of South America, the geysers of Iceland, with innumerable hot springs at Bath and other places, and the clouds of steam issuing from Etna, Vesuvius, and other vents. All these facts prove that whatever uncertainty there may be about the superabundance of heavy mineral masses on one side of the globe, there can be no denial of the existence of large and extensive cavities filled with water on the other. Hence, I assume as a fact, which, though not absolutely certain, is extremely probable, that the New Zealand half of the earth is heavier than the other half.

§ 12. Centre of Gravity and Centre of Magnitude.

This assumption makes it farther necessary to assume that the earth's centre of gravity differs from its centre of magnitude, and is situated in the diameter DE on the side of the centre of magnitude towards the part where the waters of the ocean are accumulated. It will be convenient to call the centre of magnitude c. Then let c be taken as the centre of a circle, which may represent the surface of the solid earth. It is evident that this will be a smaller circle than AEBD, the circle corresponding with the surface of the ocean; because, if the earth were perfectly spherical, as we suppose for our present purpose, and if the ocean were equally attracted on every side, it would form a sphere of water surrounding the earth,

* Proceedings of the Geological Society, vol. ii, pp. 220, 221, 393, 394.

† For particulars I refer to Fellows's "Lycia" (London, 1839), p. 184, and to my note on the passage, p. 336; also to Admiral Smyth's "Sicily," p. 171, and to his "Mediterranean" (London, 1854), pp. 140, 141. Leake, "Travels in the Morea," ii. p. 480.

and everywhere of equal depth. If therefore we take the supposed point c as a centre, and $cA=cB$ as radius, we shall describe a circle falling within the surface of the ocean ADB , and extending beyond the greater circle at E to a distance a little less than Cc , which is the eccentricity of the earth's centre of gravity.* We shall call the extremity of the radius where it meets the surface of the solid earth e .

We have thus obtained the arc of a second smaller circle, which is constructed upon the same chord, AB , with the greater circle, but which has c , the centre of magnitude of the earth, as its mathematical centre. This arc coincides with the surface of the earth where it rises above the ocean.

§ 13. *Computation of the Depth of the Ocean at D.*

It will now be our object to compute the greatest distance between these two circles at the opposite extremities of their common diameter, because the distance Dd , at the one extremity, will probably agree pretty accurately with the greatest general depth of the ocean, and the distance Ee will, in like manner, represent the greatest general elevation of the dry land above the sea-level. Of the former, *i.e.*, the distance represented by Dd , we may, I think, form a judgment from the elevation of the mountains above the ocean in the two hemispheres. We may use them as gauges, and, supposing the heights of mountains to have some approach to equality in both hemispheres, we may reason as follows. In the Land Hemisphere, the average elevation of the highest mountain masses is about 5524 metres; in the Water Hemisphere, 3604.† The difference between these two quantities is 1920 metres, which we may suppose to represent the general depth of the ocean. An ocean of this depth would be sufficient to submerge three-fourths of the solid earth, so as to leave the con-

* The distance between D and d will be equal to the eccentricity together with the difference between the two radii cA and CA .

On the other hand, the distance between E and e will be equal to the eccentricity, minus the difference between the two radii.

$$\text{Or, } Dd = Cc + CA - cA = 1920 \text{ metres.}$$

$$Ee = Cc - CA - cA.$$

† See above, § 4.

tinents and islands rising above it as they actually do. Moreover, it will be found by computation that the supposed depth would be about $\frac{1}{1831}$ part of the earth's diameter. If some such quantity as this be taken as the ordinary depth of the ocean, it will follow that where much greater depths are ascertained by soundings, these must be attributed to dislocations which have taken place at the bottom; they must be regarded as submarine seas, valleys, and lakes, analogous in their mode of formation to those which are found at the general level of the dry ground.*

§ 14. *Computation of the Height of the Land.*

Reverting to our section of the earth, we may now observe that, on the assumption of all the imagined circumstances on which the diagram is constructed, the points A, B, and the small circle of the sphere bisected by them, will be on the shores of the ocean, and will represent the water-level, which will coincide with the whole surface of the ocean, provided that it is not subject to any local and disturbing attractions. Hence the smaller arc AeB, encompassing the dry ground, will be an excrescence or protuberance rising above the water-level. Its greatest elevation will be represented by the distance between the two circles at the points E, e, which will be equal to Cc, the eccentricity before mentioned, minus the difference between the radii of the greater and smaller circles. It may be expected that this elevation should in general correspond with the elevation of the great areas of the continents, the separate mountains and ridges being regarded as the effects of local upheavals. If all the continents and islands of our earth were contracted into the form of a meniscus, that is, something like a watch-glass, or the shield of a Highland warrior, the length of any arc passing through its centre, such as AEB, being, on the supposition above assumed, an arc of 125° , would be equal to 7500 geographical miles, or about

* It has been generally assumed by geologists, and, as it seems to me, with sufficient reason, that in receding from the shores of continents and islands, the sea deepens in proportion as the land rises. According to this supposition, the deepest parts of the sea may be expected to be not much less than 1920×3 metres, which agrees sufficiently with the computations by soundings and other methods.

1380 myriametres, measured at the level of the sea. It may be observed that the solid here spoken of would be formed by the revolution upon Ee of the plane, which is bounded by the two arcs AEB and AeB.

We may now endeavour to explore the dimensions of this land meniscus, representing the continents and islands accumulated into one mass, by a method something similar to that which we have employed in regard to the supposed collection of waters.

The arc AE, being half the diameter of the meniscus, is an arc of $62^{\circ} 30'$, and is consequently equal to 3750 geographical miles, or 6945 kilometres.

What must be the thickness of this meniscus in its centre, or, in other words, its greatest elevation above the level of the sea, in order that rivers may flow from its centre to the ocean?

In reply to this question, we may compare three of the greatest rivers in Europe, Asia, and America, which flow over tracks of alluvial and sedimentary deposits, so as to have a remarkably even and gradual slope.

I. The Danube, the water of which, having been first discharged into the Euxine, forms part of the stream flowing through the Straits of Dardanelles into the Mediterranean Sea. It is navigated all the way to Ulm in Bavaria, with only a partial obstruction by rapids at the Iron Gate, where it intersects the Balkan Mountains. Its total course is reckoned at 1494 geographical miles* = 2767 kilometres. The elevation of Ulm above the sea is 369 metres.†

II. The Yenesei flows into the Arctic Ocean through a course of 4666 kilometres. The elevation of Irkutsh near its source is 378 metres.‡

III. The Missouri, joining the Mississippi, is navigable from the Great Falls in the Rocky Mountains to the sea, through a distance of 6436 kilometres.§ Below the Great Fall it is 460 metres above the sea.

The Volga rises at an elevation of only 633 English feet

* Herschel, *Physical Geography*, § 217.

† *Annuaire du Bureau des Longitudes*, p. 251.

‡ William Hughes' *Training-School Atlas*, 1861; *Physical Map of Asia*.

§ Herschel and Hughes, "4000 miles."

above the Caspian Sea. Its length is 2200 English miles. Hence its fall is only 1 in 18,350. Though perhaps an extreme instance, it suffices to show how small a declivity is sufficient to determine the flow of rivers.

These statements, compared together, give an average fall of 1 in 11332. If we apply this fact, by means of a simple proportion, to the solution of the preceding question, we shall find that the meniscus may be supposed to be 605 metres thick in its centre. At least it appears certain that this elevation would be sufficient to discharge from its surface every shower falling from the atmosphere, and to convey its water to the ocean.*

§ 15. *Another Computation by Geometry.*

I have noticed the importance of the points A, B, which are ascertained by observation. These points are at the apex of two equal and similar triangles, AcC and BcC, and it is also of great importance to Physical Geography to ascertain the elements of these triangles, since with them is connected our knowledge of the eccentricity of the earth's centre of gravity, of the general depth of the ocean, and of the general elevation of the continents above the water level. Only one of the elements in each triangle is exactly known, viz., the side CA or CB. This is the semi-diameter of the terraqueous globe, and is consequently found with the greatest ease by taking the usual divisor 3.1415926, dividing by this number 4000 myriametres, which is the circumference of the globe, and, after having thus obtained the diameter, taking the half of this as the radius. The two other sides of each triangle, cA=cB, being the semi-diameter of the solid earth, and Cc, the amount of the eccentricity, may probably be ascertained with equal exactness. At present, we shall try what can be done by the application of geometry. We may bring into comparison our two circles by means of the chord AB, which is common to both. The square of half this chord, AF, is equal

* It is gratifying to find that Professor Phillips, who has kindly perused this essay in manuscript, reasoning by a different process, makes the mean altitude of land, in round numbers, 2000 feet, which is substantially the same with my own conclusion. (*Manual of Geology*, London, 1855, p. 583.)

to $DF \times FE$ (Euclid III. 35), and it is also equal to $dF \times Fe$.
Therefore, $DF \times FE = dF \times Fe$. Hence

$$dF : FE :: DF : Fe.$$

First, to find DF and FE , it will be most convenient, and probably nearest the truth, to fix the point F , as in the preceding instance, by taking a proportion half-way between $100 : 289$ and $100 : 256$, thus:—

$$\begin{array}{r} 100 : 289 \\ 100 : 256 \\ \hline 200 : 545, \text{ i.e., } 40 : 109. \end{array}$$

We shall then obtain the two following proportions:—

$$\left. \begin{array}{l} 149 : 109 :: \overset{\text{Metres.}}{12,732,396} : \overset{\text{Metres.}}{9,314,303} = DF \\ 149 : 40 :: \overset{\text{Metres.}}{12,732,396} : \overset{\text{Metres.}}{3,418,093} = FE \end{array} \right\} DE$$

Also $dF = \overset{\text{Metres.}}{9,314,303} - \overset{\text{Metres.}}{1920} = \overset{\text{Metres.}}{9,312,383}$

And the above proportion will be expressed in figures thus:—

$$\overset{\text{Metres.}}{9,312,383} : \overset{\text{Metres.}}{3,418,093} :: \overset{\text{Metres.}}{9,314,303} : \overset{\text{Metres.}}{3,418,798} = Fe,$$

Then $3,418,798 - 3,418,093 = 705$ metres, being the measure of Ee , the thickness of the land meniscus.

Thus geometry makes the general elevation of the continents above the sea considerably more than our calculation derived from the flow of rivers, being one-seventh in excess. But it is to be observed, that the three rivers which have been selected, and which make the general elevation of the dry land above the sea only 605 metres instead of 705, flow through vast territories of remarkably even slope. It seems probable that the general elevation of the continents is greater than this even in those districts which are neither mountainous, nor characterised by any traces of subterranean action, but which consist of alluvial and sedimentary strata, and are drained throughout by navigable rivers. Hence I should be inclined to prefer 700 as the true measure of the height of the dry land above the water. This would make the height of the dry land rather more than a third part of the depth of the ocean; and it seems a remarkable coincidence that the weight of the one meniscus would then pretty nearly counterbalance that of the other, since the

specific gravity of sea-water may be considered as bearing to that of the minerals composing the crust of the earth, the inverse ratio of 19 to 7.

§ 16. *Computation of the Eccentricity.*

We now proceed to calculate the eccentricity. This is Cc in the diagram, the space through which the earth's centre of gravity is removed south-eastward from its centre of magnitude. We have already found the following equations (p. 189):—

$$\begin{array}{rcl} Cc + \overline{CA - cA} & = & Dd \\ Cc - \overline{CA - cA} & = & Ee \\ \hline 2 Cc & = & Dd + Ee \\ & = & 1920 + 600 \\ & = & 2520 \end{array} \qquad \text{Add together,}$$

Therefore $Cc = 1260$ metres.

This amount of eccentricity is found to be adequate to the production of every existing appearance, and, being much less than the length of Oxford Street in London, cannot be said to exhibit any violent or extravagant assumption.

§ 17. *Comparison with the Statements of Herschel.*

Before leaving this part of the subject, I wish to compare the preceding inferences with the statements of Sir John Herschel, not only on account of his great eminence as a philosopher, but because his “Physical Geography” is the latest publication on the science, and is replete with facts as well as theories, which are of the greatest moment in the inquiry.

Sir John Herschel estimates (p. 119, § 135) the mean elevation of the continents at 1800 feet. This is less than the calculation just made in these pages; but, if it be considered that Sir John Herschel also supposes a higher proportion of the water to the land, viz. 146 : 51, or 286 : 100, instead of the medium of 272·5 : 100 (see above, p. 178), and that as the water rises in our scheme the land will fall, it will appear that his inference rather justifies than infringes the methods of computation here pursued. Assuming his data, let us now try them by both methods.

First, by the flow of rivers.

Referring to the diagram we shall have

$$DF=146 \text{ and } FE=51, \text{ or } DF=286 \text{ and } FE=100.$$

The arc AEB will thus be reduced to about 122° , instead of 125° . The half of it will be $61^\circ=3660$ geographical miles, or 6778320 metres. This divided by 11332, will give 598 metres, instead of 605, for the elevation of the land, as above computed from the flow of rivers.

Next, let us try the investigation by geometry.

$$DE=51+146=197=12,732,396 \text{ metres.}$$

$$\left. \begin{array}{l} 197 : 146 :: 12,732,396 : 9,436,192 \text{ metres} = DF \\ 197 : 51 : 12,732,396 : 3,296,204 \text{ metres} = FE \end{array} \right\} DE$$

$$\text{Also } dF=9,436,192-1920=9,434,272.$$

The proportion in figures will be

$$9,434,272 : 3,296,204 :: 9,436,192 : 3,296,874 = Fe.$$

Then $3,296,874-3,296,204=670$ metres, thickness of the land meniscus, Ee.

Thus, as in the former case, the computation by geometry gives more to the height of the land than the computation from the flow of rivers. It is also remarkable that Herschel's statement of 1800 feet for the elevation of the continents agrees sufficiently with the deduction from his reckoning of the proportion of water to land. On the whole, therefore, I think it safe to adopt in substance his opinion, by taking 600 metres, a convenient number, as the elevation of the land, or the measure of Ee in the diagram.

§ 18. *Mass of the Sea.*

Sir John Herschel (p. 20) further estimates "the mass or weight of the sea (taking the specific gravity of sea-water under a pressure of two miles 1.0151) 3,270,600 billions of tons." He does not explain his method; but I shall endeavour to weigh the sea upon my own assumptions, and to compare the results, as one way of testing my own theory. In doing this, and more especially in guarding against mistakes in long sums of arithmetic, I have had the kind assistance of Mr Samuel Lobb, M.A. of Cambridge, late Mathematical master in the Grammar School at Highgate. Great facilities



have been afforded to us by the adoption of the metric instead of the English weights and measures.

On referring to the diagram, it will be evident that the quantity sought is the difference between the two circular segments ADB and AdB. To find it Mr Lobb has given me the following formula :—

$$\text{Water-meniscus} = \pi \cdot FD^2 \left(R_w - \frac{FD}{3} \right) - \pi \cdot Fd^2 \left(R_l - \frac{Fd}{3} \right).$$

On working it out he makes the cubic contents of the water-meniscus to be rather more than 3,157,302 billions of cubic metres. Consequently the ocean contains, on the preceding assumptions, an amount equal in weight to so many billion tons of pure water, because the weight of a cubic metre of water is a metric ton. But it is necessary to add .0151 per cent., as Herschel has done, for the greater weight of seawater, and .0156 per cent. on account of the quantity by which the English ton exceeds the metric ton. These percentages added together make about 3 per cent., and will bring our computation within a very little up to Sir John Herschel's.*

§. 19 *Symmetry of the Terraqueous Globe.*

In discoursing upon such a subject as the present, it becomes one, who does not profess any familiar acquaintance with the mathematical and physical sciences, to express himself with caution, modesty, and reverence. In conclusion, therefore, and in this spirit, I wish to reply to the objection which will be raised against my theory, as contrary to our notions of the symmetry and beauty of the material universe.

I might reply, that plain matters of fact must be admitted, however contrary to our private wishes and feelings. We must not refuse to look at a Begonia on account of the inequality in the form of the leaves, which strikingly pervades

* Having proceeded thus far, we are enabled, by the further application of the Metric System, almost at a glance to estimate the mass of salt in the sea, that is, of the solid contents which would be left behind if all the water were evaporated. It appears that it would be something more than 400 cubic myriametres. I would observe that Forchhammer estimates the solid matter in the ocean much higher; viz., 34·304 per 1000. (*Proc. of R. S.*, May 1862, p. 131.)

the whole genus. But I think that a careful examination of the present question will show that there is not the slightest ground for the objection.

According to the view which I have endeavoured to explain, the eccentricity of the earth's centre of gravity is balanced by the attraction of the ocean to the south-east, by which the centre of gravity of the solid earth becomes also the centre of gravity of the terraqueous globe. The protuberance of the water on one side will make the centre of gravity of the terraqueous globe coincide with its geometrical centre, which will be in the same diameter with the previously assumed centre. Again, when the atmosphere comes into action, its centre of gravity will coincide with the centre of gravity which has already been assumed, first, for the earth, and, secondly, for the terraqueous globe. The original extra weight of the earth on one side will thus be balanced by the greater lightness of the water on the same side. The result will be, that the centre of gravity of the whole system will coincide with its geometrical centre and determine its axis of rotation.

§ 20. *Important Consequences of the Eccentricity.*

It might be presumptuous in beings so ignorant as we are to say that the eccentricity here spoken of is intentional; but it is certain that it produces the most useful and admirable results. This appears more especially in considering the land hemisphere. Were not the force of gravity such as it is, the whole surface of the meniscus AEB would become a swamp. The waters falling from the sky would necessarily remain where they fell. But the force of attraction draws them down declivities on every side of this meniscus; it unites them into streamlets, brooks, and rivers, and at length they reach the level of the line AB, and mingle with the ocean. In going down the declivities they dig channels in the surface of the meniscus, which become larger and larger by their union. The surface is thus eroded and carried off in the state of sand, mud, and pebbles, and these solid materials, as soon as they have reached the ocean, are deposited beneath the water at its edge. If this process were to go on interminably, the whole meniscus would be worn down and brought to

a level with the ocean; but here another agent begins its work. The internal heat disturbs the primæval repose, raises, and often breaks, the ribs of rock, and either elevates the surface of the earth by a gradual and general intumescence, or, in a more sudden paroxysm, exhibits the upheaval of a lofty range of mountains. By processes of this kind, the land hemisphere assumes the useful qualities and the beautiful and varied aspects which we now behold. Mountains in lengthened ridges, which have in most cases turned on an axis as the lid of a box turns on its hinges, present gradual slopes on one side and bold precipices and escarpments on the other, and thus penetrate the regions of eternal ice. These mountains are the chief condensers of the atmospherical waters, which flow down the plains and steppes as already described, until they discharge themselves into the ocean, every great stream being divided into its torrential portion, passing through the elevation and its navigable part, which marks and measures the general surface of the Land Hemisphere. Such are the wonderful and beneficent consequences, distinctly traceable to the eccentricity of the earth's centre of gravity.*

§ 21. *Solidity of the Earth's Centre.*

An obvious consequence of the theory here propounded is the general solidity of the earth's interior. To say nothing of the "great abyss of waters," held by Burnet, Woodward, and others, all the recent theories of a liquified or incandescent state of the interior of our planet must be rejected on this hypothesis; for in such circumstances the force of gravity would so act upon the moveable fluids as to make the two centres of magnitude and gravity coalesce. In short, the eccentricity, which is an essential part of this theory of the earth, would be obliterated. It is, indeed, possible, perhaps even probable, that there may be in the innermost parts of the earth cavities filled with mercury or other heavy fluids, and so far answering to the cavities filled with water in its exterior;

* Respecting the precise mode of action of the atmospherical agencies in disintegrating, eroding, distributing, and rearranging the solid materials of the earth's surface, I beg to refer the reader to my Memoir communicated to the Geological Society of London in November 1830, and published in the "Edinburgh New Philosophical Journal" for July 1831.

but I conceive that a solid framework of rock must nevertheless extend from every part of the earth's surface to its centre. At the same time it is clear that the two centres of magnitude and gravity, being mathematical points (C, c, in the diagram), are far from being immovable; on the contrary, they must move so as to correspond with the changes of position of all substances on the earth's surface. Every day they must approach or recede to the extent of at least some millimetres, in obedience to the flight of clouds and other atmospheric agencies, and still more in consequence of the removal of detrital matter, and of the subterranean forces of upheaval.

§ 22. *Permanency of the Earth's Surface.*

The doctrine of two centres, thus intimately connected with the distribution of water over the earth's surface, further presents an important view of the general permanency of that surface. If the centres were to coalesce, or if they were either to approach or recede to any considerable extent, not only the relative proportions of sea and dry land would be changed, but the forms and boundaries of all continents and islands without exception would be completely altered. Now we know that this has not been the case for an indefinite length of time. We have historical proofs that the great landmarks of the old world, the main boundaries of Europe, Asia, and Africa, are the same now as in all former periods of which we have any record, and we may probably extend this inference even to vast geological epochs, inasmuch as the fossil remains of quadrupeds are sometimes found to belong to certain orders in their appropriate regions, of which we have a striking instance in the discovery of an abundance of marsupials in Australia throughout all periods, both ancient and modern. So far as we can judge, Australia always was Australia, and, notwithstanding the immense superficial changes continually in progress, the larger elevations and depressions of our globe remain from age to age in much the same relative position, a result which could not be expected unless the innermost parts of the earth were so precluded from motion as to confine the two above-defined centres within very narrow limits, and with extremely little variation in their distance. Here a

very important observation of Professor Phillips appears apposite, as a confirmation of my reasoning: "By no stretch of conjecture, that is not absolutely monstrous, can we torture the known laws of terrestrial arrangements into agreement with the hypothesis of any but small changes of the level of the ocean; a conclusion of the highest value, since it enables us to argue upon that level as a general standard, to which we may refer all the effects of internal movements, in whatever period, and by whatever forces produced." *

§ 23. *Constitution of the Earth's Interior.*

Having ventured to dispute the commonly received doctrine of the fluid or liquified state of the central parts of the earth, I may be required to suggest some better hypothesis. Let us then suppose, in conformity with the example of most of our predecessors, that the earth originated in a mass of vapour. It has been commonly assumed, that this would condense into a fluid. I think that for the most part it would become solid without passing through the fluid state, because this appears to be the case with most substances, whether simple or compound, of which we have any knowledge, *e.g.*, iodine, camphor, sulphur, carbonic acid (as shown by Thilorier), metals and their oxides, with innumerable other bodies. These matters, even in their extreme state of comminution or vaporisation, show a disposition rather to crystallise at once than to become fluid. The most common earths, such as clay, silex, and felspar, in the finest dust become gritty, when immersed in water, agitated, and allowed to subside. But the most familiar example occurs in the formation of snow and hail; and more especially, we may appeal to those hailstones, of rare occurrence, which become very destructive in consequence of their great size, which are rough and irregular in form, and are produced by the aggregation of a multitude of smaller crystals. In like manner, the pre-existent vapour, whirling round a centre, and composed as the earth now is of more than sixty elements, would crystallise, first, into an endless variety of simple and compound bodies of small dimensions,

* *Manual of Geology* (1854), p. 584. Compare Humboldt's "*Cosmos*," Sabine's *Trans.* vol. i. p. 278.

and gradually into larger and larger masses, until some of them might even approach our conception of planetoids or asteroids. The tendency of all these heterogeneous bodies, though long kept separate by the centrifugal force, would be to fall together by degrees, always whirling round their centre of gravity, and assuming the form of a spheroid of rotation. Fluids might originate in the process, and mingle with the general system; but the formation of an entirely fluid spheroid would, as it appears to me, require such peculiar conditions of temperature and pressure as would be very improbable at any time.

§ 24. *Chemical Agency.*

The theory which I have endeavoured to trace presents an unbounded field for chemical contemplation. The able arguments of Mr Sterry Hunt* and others, in regard to the formation of metamorphic rocks, might be applied to all combinations of matter, down to the very centre of the earth. The doctrine of chemical affinities seems to combine with numerous geological phenomena in proving that metallic alloys, and all solids of heterogeneous composition, are subject to slow internal changes, the atoms of matter being destined gradually to overcome the contiguous mechanical impediments, so as to arrange themselves ultimately according to their greatest affinities; and, if this be so, another important consequence seems to follow, namely, that chemical action will evolve heat, which will be continually propagated upwards and outwards. Thus the most striking events and appearances on the surface of our planet, such as thermal springs, earthquakes, and volcanoes, may stand in direct though distant relation to the excess of water in the region round New Zealand.

§ 25. *Magnetic Storms.*

The evolution of heat, combined with chemical action, can scarcely fail to have an influence on the magnetism of the earth, and, notwithstanding the obscurity of the subject, the question suggests itself, whether the so-called "magnetic storms" may not be explained on this theory. We seem to

* In Quart. Jour. of Geol. Soc. 1859, p. 489.

have arrived at something like evidence of the existence of cavities in the interior of the solid earth, irregular in their form, communicating occasionally with one another, and containing various substances in a fluid or aeriform condition. These may from time to time burst through their barriers, and either fall downwards or rise to some receptacle nearer the surface. Such sudden and varied motions within the earth appear to exhibit some relation to the action of the needle, when, instead of trembling "to the pole," it suffers a mysterious and violent agitation.

This view of the origin of magnetic storms appears to be supported by the fact, that the needle exhibits the same kind of agitation in the vicinity of volcanic eruptions. Also, it is important to observe that the cause of earthquakes has been shown to be very deep-seated. The seat of the great earthquake at Lisbon was investigated by Professor John Playfair, by a reference to its diffusion over the earth's surface, and was calculated by him to be at an immense depth beneath the surface.* If this remark be taken in connection with the fact that magnetic storms are in like manner "simultaneous, in the strictest sense of the word, over land and sea, over hundreds and thousands of miles,"† all seems to tend to the inference, that the central parts of the globe are subject to the same kind of convulsions, which we call earthquakes and volcanoes, when they occur immediately beneath our feet.

§ 26. *Proposed Theory agreeable to Ancient and Established Doctrines.*

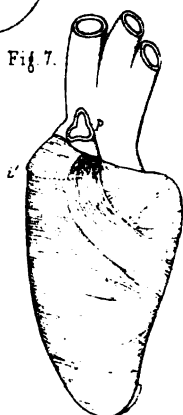
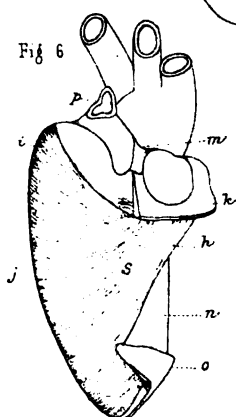
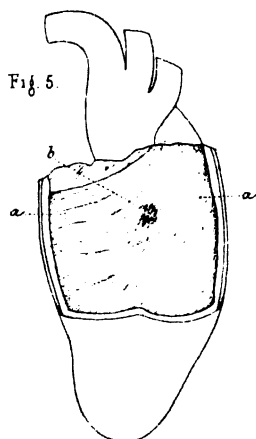
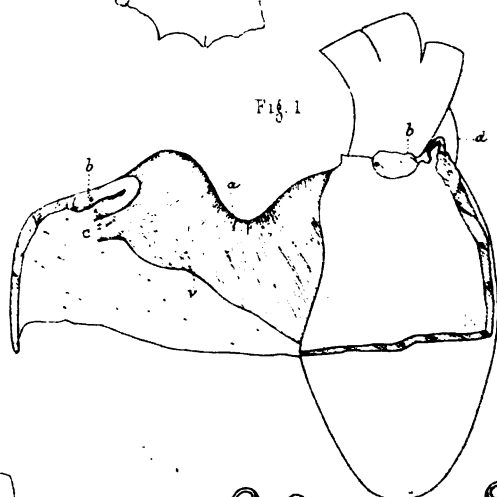
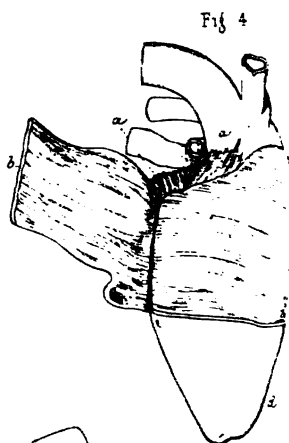
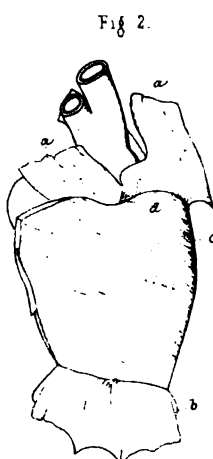
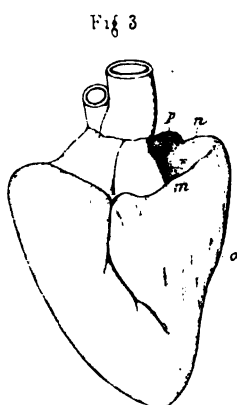
According to Diogenes Laertius (ii. 1.) the doctrine of the sphericity of the earth was taught by Anaximander, so that it appears to have belonged to the earliest period of the Greek philosophy. From the Greeks it passed to the Romans. Ovid clearly states it in the well-known lines, which are now found to be exactly and literally true:—

Circumfuso pendeat in ære tellus,
Ponderibus librata suis.

Met. I. 12, 13.

* Trans. of Royal Society, Edinburgh, 4to, about A.D. 1812.

† Humboldt's "Cosmos," Sabine's Trans. i. pp. 24, 167, and Note 143.



Plato briefly expresses the opinion, that the frame of the universe was constructed with the nicest adjustment of parts, when he says, "Ὁ Θεὸς ἀπὸ γεωμετρίας."—"The Divinity always acts geometrically," that is, by just and adequate "numbers, weights, and measures."* In the Sacred Scriptures the same idea is beautifully expressed in various passages. Wisdom was present when God "set a compass on the face of the deep" (Prov., viii. 27). Here is a reference to the use of the compasses in geometry, the word in the Hebrew being *og*, the origin of our word ocean.† Every one will call to mind the verse of Isaiah (xl. 12), "Who hath measured the waters in the hollow of his hand, and meted out heaven with the span, and comprehended the dust of the earth in a measure, and weighed the mountains in scales, and the hills in a balance?" According to the conception of the writer, not only was the earth spherical, but the atmosphere, the ocean, and the crust of the globe, were all adjusted by weight and measure. Thus it appears to me, that the theory which I have advanced respecting the equipoise of our planet is conformable to the most ancient and venerable principles of oriental wisdom, whilst it explains the actual course of nature, when, in the language of our own learned, philosophical, and sublime poet,

"Earth, self-balanced, on her centre hung."

On the Arrangement of the Muscular Fibres of the Valve in the right Ventricle of the Heart in the Bird.‡ By W. CARMICHAEL M'INTOSH, M.D., Perth. (Plate III.)

Everywhere throughout the mammalian series is found at the right auriculo-ventricular orifice an arrangement of fibrous valves connected with *cordæ tendineæ*, *columnæ carneæ*, and

* Bentley, Sermon at Boyle's Lecture, No. viii., 5th edit., p. 304.

† Compare Milton, *Paradise Lost*, vii. l. 224-242.

‡ The most of this paper formed a fragment of an essay "On the Arrangement of the Muscular Fibres of the Ventricular Portion of the Heart in Vertebrata," given in during the Winter Session 1858-9, for competition in the Senior Anatomy Class of Professor Goodsir.

musculi papillares, whereby regurgitation is prevented, and other important steps in the economy of the cavity furthered. In some, too, we have muscular fibres developed in these valves, as in the horse and dog, while in the *Ornithorhynchus paradoxus* a large amount of this tissue is stated to be found; thus, as it were, forming the connecting link by which we arrive at that curious structure in the right heart of birds. The left ventricle in the latter contrasts strongly with the single muscular valve of the right, since it has fibrous valves similar to those in the mammal.

Without referring at present to all the peculiarities of the bird's heart as distinguished from that of the mammal, it may be mentioned that, after boiling, the bases of the two differ especially in the comparative shapes of the auriculo-ventricular openings. In the bird, the left is circular and surrounded by a solid ring of the thick muscular wall; the other presents an elongated slit-like curve with its convexity to the right. There being no annulus venosus, the auricle is continuous with the thick layer of endocardium which covers the auricular or septal side of the valve, except at the ends, where there are firmer fibrous connections. There is only a very slight fibrous margin to the free edge of the valve.

In examining into the special arrangement of the muscular fibres necessitated by the valve, which is seen entire in fig. 1., *v*, I shall in the first instance pursue those from the right or proper wall of the ventricle, according to their depth and direction, and thereafter any additional bands which this method leaves undetermined.

In most birds' hearts the superficial fibres which assist in the formation of the valve have a pretty uniform course, as coiling out at the apex, they proceed upwards, and bending to the right, many sweep over the brim of the right ventricle, and form part of the septal surface of the valve. Without dissection it may be seen, that, when turning the margin of the brim, some diverge to the anterior fillet obliquely downwards and forwards, meeting fibres which come from the free ventricular wall; others spread over the septal surface of the valve; while a third set plunge backwards into the left ventricular wall; and we shall meet them again when describing the

great band of fibres at this part. On raising these superficial fibres, as seen in fig. 2 (where *aab* are portions of the superficial fibres reflected), it is found that most take a direction obliquely forwards over the brim and septal surface of the valve, some joining the general mass of fibres at the anterior angle, others merging into the accessory slip from the free wall of the ventricle. Many of the superficial fibres likewise sink into the fillet which often so conspicuously guards the anterior part of the valve and ventricle. See *np*, fig. 3.

The subjacent fibres course at an acute angle to those we have just described, and proceed exactly in an opposite direction, the superficial mounting upwards and forwards, the deeper sloping upwards and backwards. The great mass of fibres forming this layer of the right ventricle are seen coursing from the anterior surface of the left ventricle upwards and backwards. Some make a twist, and join that fillet which plunges into the septum past the root of the aorta, and form part of the highly important arch of muscle at *n* and *p*, fig. 3, previously mentioned, which covers in the anterior and upper part of the ventricle, and completes the smooth pouch terminating in the aperture of the pulmonary artery. Other fibres of this layer (seen at *d*, fig. 2), slanting upwards, come to the brim of the ventricle and also of the valve; and here they fold over and proceed downwards and backwards, forming the greater part of the substance of the valve, to the posterior border of the ventricle, and crossing the septum enter the left ventricular wall, where they will be pursued by and by. A third set, to the left of *d*, fig. 2, curve inwards and upwards to be attached to the cartilaginous setting at the posterior part of the aortic base at the septum,* and assist in the completion of the margin of the ventricle. The brim of the ventricle is of a different construction here from what it is at the anterior angle; for there the mass of the valve has merged into the proper wall, leaving the brim unprotected as regards any fibres essentially connected

* By prolonged boiling, it is probable that the muscular fibres may be conveniently separated from the tendinous rings, since many dissections of the heart of the mammal, as well as of the bird, have convinced me that numerous fibres are inserted into these structures.

with it, while at the posterior part the brim of the ventricle is continuous with the margin of the valve, new fibres, even to the last, folding over to join the general body of this structure.

When this layer is raised, the great bulk of the fibres is seen to enter into the formation of the oblique band after doubling the ventricular brim; the rest continue in succession to the posterior border, some forming part of the posterior portions of the valve, others being inserted into the cartilaginous setting at the aortic base, or plunging, are lost in the septum. The fibres that course over the upper part of the ventricle take most part in the formation of the oblique band, the others assist in the construction of the posterior arch of the valve.

The deeper portion of these fibres, from their forming a smaller angle with the brim, make another layer of ventricular fibres, but their relations to the valve are somewhat similar. They are seen at *cc*, fig. 4. The fibres at the root of the pulmonary artery—belonging to this and the previous layer—take great part in the formation of the origin of the valve; that is, its prominence anteriorly from the rest of the cavity is caused by the bulging of fibres from that region.

There is no difficulty experienced in raising the foregoing from the innermost or fourth layer, most of whose fibres slant in an opposite direction. That portion of the internal layer, seen at *aa*, fig. 5, chiefly coming from the pulmonary region, takes little part in the formation of the valve, except in joining that structure with itself, and in giving *musculi pectinati* to its outer surface to strengthen the connection. Posteriorly it wends up to the brim in a similar manner, some of its fibres entering the left wall, others becoming attached to the cartilaginous setting mentioned previously. The most important connection of the internal layer with the valve is its relation to the accessory slip. A strong band of fibres is seen coursing down from the right half of the pulmonary artery over the upper part of the right ventricle, which, arriving at the point of attachment of the slip, gives many of its fibres to assist in its formation by means of a well-marked twist. Out of the slip itself a band emerges, which sweeps over the upper part



Ash-tree at Moredun,
struck by lightning.

of the ventricle in the course of the other fibres of the internal layer, and, like them, being attached to the fibro-cartilaginous setting posteriorly, and also taking part in the posterior arch of the valve. At this point of ingress and egress an evident dimple is produced; see *b*, fig. 5. It is very distinct in many hearts, and the arrangement forms, as it were, a sling by which the accessory slip is hung.

The valve has thus connections with all the layers of the ventricle, its most powerful bundles coming from the second layer, and from the pulmonary band of the fourth layer in connection with the accessory slip.

The *accessory slip* of the valve (fig. 1, *c*), as has been seen, comes chiefly from the inner layer of the free wall of the ventricle, and has the aspect of a large and powerful muscular column, which, tacked to the yielding anterior edge of the valve, has an important influence in its action. Springing in the fan-shaped manner already described, the fibres, converging, pass along its pillar, again to diverge when they meet those of the valve. In some hearts the fibres pass a little way up beyond the lower margin of the valve. On either side, then, it has pretty extensive connections, which must be correspondingly affected by the movements of its column. There is a thin muscular band attached to the upper margin of this structure, which connects it with the fillet crossing to pass into the septum at the base of the aorta.

The *Great or Oblique Band* of the valve (fig. 6, *h*) is that mass of fibres which takes a slanting and well-defined course from the brim of the ventricle to the septum, from right to left. On the inner or septal surface it is less distinct, but, externally, it forms a prominent column of muscle, constituting, in fact, the whole external aspect of the valve, with the exception of the accessory slip. In most hearts, the direction of the fibres is uniformly oblique; but in the heart of the Emu, and probably in others, a fillet of nearly horizontal fibres at the upper part breaks the usual obliquity. Following the fibres of this great band into the left ventricular wall, it is seen that, on passing the septum (*s*, fig. 6), their course is somewhat altered; for many gently curving over the posterior part of the left wall spread and intermingle with other

fibres taking a similar direction ; as seen in the figure. Many of the superior fibres slant upwards to be attached with accompanying fibres to the cartilaginous setting near the root of the aorta, anteriorly, and to the left (*i'*, fig. 7). The rest, forming a portion of the third layer of the left ventricular wall, coil with it through the septum, and are no longer distinguishable.

It will thus be seen that the single valve in the right ventricle of the bird's heart is no simple structure, but that, from the direction of its fibres and its connections, its action must be somewhat complicated. In the relaxed state, the rounded margin of the right ventricle presents a concave surface to the septum ; and the latter being continuous with the valve, it is clear that any movement in either must correspondingly affect the other. When contraction of the valve occurs, its actions, judging from the anatomical structure, would seem to be the following:—The right or proper wall will be forcibly approximated to the septum, the concavity of the border or brim becoming lessened ; the falciform edge will also be tilted upwards by the obliquity of the fibres which slant over the brim, thus closing the auriculo-ventricular opening, and preventing regurgitation. The fibres of the oblique band would seem to depress the brim of the ventricle, and, the cavity being filled with blood, would present in its connection with the free wall an irresistible propulsive or compressing force to the fluid. But it may be thought that, since the valve does not extend entirely across the cavity, the blood will escape through the opening where the valve is small and imperfect, as at its origin, anteriorly ; this is provided against by the cavity being arched over at this portion by the fillets near the aortic base, previously described, so that the pulmonary channel alone being patent, no obstacle is afforded to the speedy passage of the blood. If the pouch of the valve is examined when the ventricle is filled with coagulated blood, the wise provision of the oblique arrangement of the fibres is readily observed ; for they permit of extreme dilatation in all directions. This is very well seen in cases where the heart is boiled with its right ventricle filled with blood ; the fibres of the valve and the upper part of the ventricle are stretched and

attenuated to the utmost, yet in no case did I ever observe rupture.

EXPLANATION OF FIGURES.

Fig. 1. Heart of Capercaillie. The right ventricle is opened by the usual incisions for exposing the valve; *av*, the septal surface of the valve, with the varying direction of its fibres; *bb*, the cut surfaces of the muscular arch, which closes in the pulmonary region; *c*, the accessory slip; *d*, the pulmonary artery disappearing behind the aorta.

Fig. 2. Heart of the Heron, showing the superficial fibres reflected at *aab*, and likewise those fibres *cd*, of the second layer, which are connected with the formation of the valve.

Fig. 3. Superficial fibres of the heart of the Swan, from the posterior aspect; *m* and *o* are the superficial fibres passing over into the valve; *n* and *p*, the fillet and the arch of muscle, which complete the anterior and upper portion of the right cavity.

Fig. 4. Heart of the Swan, exhibiting the third layer of fibres *cc*; *b*, the second layer reflected; *aa*, portions of the same which could not be raised entire on account of their peculiar bending over the valve.

Fig. 5. Internal fibres *aa* of the heart of the Swan, as they slant from the pulmonary region; *b*, the twist caused by the entrance and exit of fibres connected with the accessory slip.

Fig. 6. Heart of the Capercaillie; *h*, the great or oblique band; *ij*, diverging fibres, connected with the same; *k*, the prominent brim of the ventricle; *m*, the cartilaginous setting at the posterior coronary track into which many fibres are inserted; *n*, the smooth or septal surface of the ventricle; *o*, the mass of muscle wending round the apex; *p*, the aperture of the pulmonary artery; *s*, point of junction of the right or free ventricular wall with the septum.

Fig. 7. The same heart turned round to exhibit the course of the upper diverging fibres, *ii'*, of the oblique band, as they sweep to the region of the aorta, anteriorly, and to the left.

Remarks on the Nature and Peculiarities of the Fern-spore.

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The second volume of the Linnean Transactions contains a paper on the development of fern-spores, by Mr Lindsay. This was read before the Linnean Society in January 1792, and appears to be the earliest record of the production of these plants from spores. Since that period, the spore, its nature and peculiarities, have been the subject of frequent discussions, without eliciting, however, any perfectly satisfactory conclusions. This can scarcely be attributed to any inherent anomalies, but rather to an unfortunate desire, in many instances, to

* Read before the Botanical Society of Edinburgh, 12th June 1862.

homologate essentially distinct organs, *i.e.*, buds and spores. The fallacy of this view has been so repeatedly exposed, that a re-statement may appear quite superfluous, were we not confronted with the fact, that authors still persist in ignoring the distinction, so lucidly drawn by Carpenter, Berkeley, and others, between the terms Homology and Analogy. This tendency of studying from preconceived hypothetical stand-points, is, we think, the chief source of the intricacy pertaining to the subject we are about to consider.

The following remarks lay small claim to originality, being in most instances re-statements of those peculiarities and anomalous properties of the fern-spore which are said to render all explanations of its nature hitherto offered unsatisfactory. In one or two instances, however, there will be found notices of certain peculiar properties, which, so far as we are aware, have not been recorded before, and likewise a few remarks explanatory of those peculiarities, the correctness of which, however, we leave to the judication of others. On these considerations, then, and as a record of conclusions based on a series of careful observations of the fern-spore in its various stages of development, the following remarks may not, perhaps, be deemed superfluous.

The sporanges of ferns are generally attached to the lower surface of the frond, though in the *Polypodium anomalum* they are confined entirely to the upper. The spores are productions of cell-division within these, and, accordingly, unattached. They consist of simple cells, having two coats like pollen grains, the outer of which is variously marked with warts, spines, or reticulations. The history of their development is similar in every essential respect to that of pollen grains, being, like them, products of a free cell-formation. This, however, is a point entirely ignored by those who regard the spore as the homologue of the flower or leaf-bud, and hence, we are inclined to think, arise the difficulties in giving an explanation of its apparently anomalous properties. For it can scarcely be denied that all proposed explanations, at least of that peculiar facility afforded by spores for the reproduction and perpetuation of any accidental variation of the parts upon which they originate, are, upon the whole, in-

sufficient. The most satisfactory, as we are inclined to think, is contained in a paper "On the Production of Ferns from Spores," by Professor Balfour, in the Trans. Bot. Soc., vol. vi. It is there remarked, "that the spores which are not the direct products of reproduction, may be regarded as analogous to parthenogenetic seeds." . . . "These may have a tendency to propagate particular forms of plants, just as is the case in *Cœlebogyne*, where female plants have always been produced by seeds said not to be acted on by pollen. In this way, then, we may account for the spores of those fully developed anomalous forms always reproducing varieties like their parents." This view, so far as regards the nature of the spore, appears to be perfectly satisfactory; it seems, however, scarcely to meet the exigencies of the case, when we consider the spore in connection with its peculiar properties. In the offspring of parthenogenetic seeds, we have no positive evidence of their propagating other characters differing from the normal specific type except as regards the sexual organs, which, in fact, are specifically normal; whereas in ferns other abnormal characters are regularly reproduced.

Another explanation has been proposed by Dr Lowe in his paper "On the Homologies of the Floral Organs of *Phanerogamia* and the Higher *Cryptogams*," of a very different nature from the preceding. In it the author believes that this peculiarity, *i.e.*, of reproducing anomalous forms, "can be explained only on the supposition that the spores are nothing more than buds, and that the real act of reproduction comes after their separation from the parent plant." But, aside from the difference of origin of the *bud* and *spore* before alluded to, we cannot but regard this explanation as entirely opposed to the laws governing the reproduction of variations in *Phænogams*. It appears to be generally admitted that the longer the incipient plant is developed under the direct formative tendency of the parent, the more will it partake of its individual peculiarities; that this is, in short, the cause of buds reproducing the peculiarities of their parents. In reproduction by seed, on the other hand, an embryo is separated from the individuality of the parent, "and develops itself out of itself, so that the influence which the parent plant exerts,

even though it be definite and assimilative, is yet always an external one, and is modified by the peculiar vital power of the reproductive cell;" hence, in reproduction by seeds, the specific characters alone are in general reproduced. Now, in the fern spore, we have an organ still less developed, under the direct formative tendency of the parent, than even the seed; as, according to the theory we are examining, the embryo is not alone separated from the individuality of the parent, but all the floral organs are developed in perfect independence of it, so that the definite and assimilative influence exercised by the parent over the embryo of the seed, small though its individualising influence may be, is not even called into action in the case of the embryo developed from the spore. Hence we are certainly justified in asserting that were these organs the homologues of buds, floral or foliar, the reproduction of the morphological variations of the individual must be rare in the extreme—the exception not the rule—so purely dependent is the incipient plant on the specific morphological tendency.

Again, in a paper by Mr W. K. Bridgeman, entitled "The Influence of the Venation in the Reproduction of Monstrosities among Ferns,"* the author supposes that this peculiar property of spores is dependent on an abnormal distribution of the veins. This opinion is formed on a few experiments made upon certain abnormal forms of *Scolopendrium vulgare*, in which the venation was abnormal in one part of a frond and normal in the other. Selecting a frond of the variety *laceratum*, and taking spores from a reticulated and abnormal veined portion of the frond, the author found that the offspring from these spores exhibited the same characteristic forms as the parent frond. Those, on the other hand, taken from the normally veined portion of the frond, exhibited few of the characteristics of their parent, a large proportion of them being perfectly normal. On these, then, and one or two more experiments, the author believes, as before stated, that the reproduction of varieties is dependent upon an abnormal venation. This, however, is little more than a new mode of expressing the fact, that the spore reproduces the part upon which it originates. The statements differ from

* Mag. of Nat. Hist., December 1861.

each other, however, in this respect, that the view under examination appears to regard the form of the pinnæ as dependent on the venation, while the other avoids particularising, and makes no attempt to solve the question, whether the distribution of the veins influences the form assumed by the parenchymatous tissue, or *vice versa*. The latter view is held by Dr Dickie, who remarks that the quantity of cellular tissue in a leaf determines the development and position of the veins. Not pretending, however, to decide such a question, we may simply remark, that in the majority of ferns there is little or no departure from the normal venation of their respective species. Few will be found to exhibit so striking a departure as some of the crested forms of *Scolopendrium vulgare*. Nevertheless, it is an acknowledged fact, that the spores from normal-veined, though abnormal-formed, fronds, do reproduce with great regularity the latter peculiarity. The numerous varieties of the British ferns now annually raised from spores, in which there is no departure from the normal venation further than a greater or less development of them reciprocally with the tissue, affords sufficient evidence on this head. We should like to know in what manner the variegated ferns are dependent upon an abnormal distribution of the veins for the perpetuation of their peculiarities. In fine, we are induced to regard the produce of the spores from the differently-veined portions of the *Scolopendrium* as merely a casual concurrence, from the superabundance of evidence demonstrating the reproduction of variations with a perfectly normal venation. And there is not, so far as we are aware, a single instance on record, of the reproduction of an abnormally-veined frond or pinna, in which the form of the parenchymatous tissue was normal. An example of this kind is required to demonstrate the possibility of the reproduction of an abnormality in the venation alone. Instances of this kind would certainly appear to be very rare. Berkeley, alluding to a paper by Dr Hooker on the "Vegetation of the Carboniferous Period," as compared with that of the present day, observes that two pinnules are there figured of the *Callipteris malabarica*, in one of which the veinlets anastomose, in the other they are perfectly free. As we have not had an opportunity of seeing these figures, we

cannot say whether they differ in form or not; but we have observed pinnules upon this fern with free venules, differing in no respect from that characterising a normally-veined pin-nule. This, then, is an instance in point, and would serve to illustrate in a certain degree the power of the venation in the reproduction of its own abnormalities. As yet we have never had an opportunity of trying the experiment, as we have not succeeded in finding spores upon one of those abnormally-veined pinnules. Although Mr Bridgeman has, in our opinion, failed in showing conclusively the influence of the venation in the reproduction of variations, he has nevertheless furnished us with interesting illustrations of that peculiar individualising power possessed by the fern-spore, even in a continuous tissue, as occurs in *Scolopendrium*, by which it reproduces the form of the part upon which it originates.

It now behoves us to enter into a more particular examination of the spore in its different stages of development, to exhibit those physiological peculiarities which render it so distinct from the organs of phænogams having a similar functional import. And we trust that by thus exhibiting the very distinct conditions of the reproductive organs in ferns and the higher plants, we shall be enabled to understand the nature of that peculiar power of spores which affords such great facilities for the reproduction and perpetuation of individual variations.

The reproductive organs of phænogams, as is well known, are always products of two morphologically distinct organs, the stamens producing the pollen, the carpels producing the ovules; if they be not, as some authors are inclined to think, physiologically distinct, *i.e.* the *anther* a modified leaf, and the *ovule* a modified extremity of the stem. This separation of the reproductive structures, and their necessary union for the development of the embryo, must tend to impress more fully upon it the essential characters of the species. The embryo being in this case the *modified resultant* of two originally distinct organs, there will necessarily be a greater tendency to efface any individual peculiarities of these than would have been the case, had the embryo been the product of a single organ. And this is simply an application of the laws of hy-

bridisation for the reproduction and continuation of the normal specific form. As it is well known that a hybrid may in a few generations, by repeatedly crossing the successive offspring with one of the original parents, be brought back, or nearly so, to the normal form of that parent, so in the case of the specific individual, the reciprocal action of distinct morphological organs—stamens and pistils—for the production of the embryo, will have a tendency to modify the occasional variations these organs may individually be liable to in the *resultant* of their combined action, and thus be a comparative safeguard against any sudden divergence from the characteristics of their parent.

The relations of the reproductive organs of thallogams to the morphologically perfect plant, are, on the other hand, very different from what obtains amongst phanerogamous plants, as the following summary will show. The fern-spore, as before stated, originates free in the sporangial sac, the latter being an immediate product of the foliaceous structure. After its discharge from the sporangial-sac, it produces, in favourable conditions, the prothallus, upon which the true organs of reproduction are ultimately produced. The formation of the latter organs in general closes the developmental history of the spore and its prothallus; an archegonial cell, or, as instanced by a prothallus of the *Adiantum pubescens* in the Edinburgh Botanic Garden, two of these cells have been impregnated, each of which has produced a perfect morphological representative of the parent. It occasionally happens, however, that none of these cells are impregnated, and in this case the prothallus frequently exhibits an interesting analogy in its gemmative powers to those lower order of plants which it morphologically resembles—each cell seeming to possess an independent formative power, and generating secondary prothalli, morphologically similar to the primary one. As this formative power seems not to have been observed, or at least recorded before, we shall take the opportunity of illustrating it in a subsequent part of this paper.

The phenomena indicated in the preceding brief detail of the origin and development of the spore, justify the following deductions explanatory of its peculiar individualising powers.

The spore has been defined, "the ultimate germinating cell of the plant"—*objectively*, an independent organ of generation, *subjectively*, however, and truly, part of the individual cycle of the plant upon which it originates. This latter relation is, we are aware, denied by Hofmeister and others, who, in accordance with Steenstrup's theory of alternation of generations, regard the spore and its immediate products as a distinct and perfect generation. This, however, as has been observed, confounds the true generative process with a mode of mere gemmative development; hence, we prefer to apply Huxley's definition of the zoological individual to the merely objective definition which Steenstrup's views afford, and, accordingly, regard the *phytological individual* as being equal to the total result of the development of a single fertilised ovule, the cycle of individuality being only completed with the generative act. The spore, then, being an independent self-developing organism, produced by a lateral organ, the frond, and undergoing no modification by the *immediate* action of any others, *similar to what obtains in the production of the Phanerogamic embryo*, is, consequently, less influenced by the *specific morphological tendency*; and this, we believe, affords a full explanation of the phenomena in question. The spore, being a product of a single lateral organ, and thus uninfluenced by the restrictive modifications of any other, inherits and reproduces the peculiarities of this organ, or rather that part of it upon which it originates, with *greater facility* than those characteristic of the species. This view is furthermore supported by the fact, that abnormalities of the pinnæ are inherited with much greater facility than a rachidal deviation, thus demonstrating, that even in those parts of the frond less directly connected with the spore, the *specific morphological tendency* becomes equally as energetic as the *individualising*. In illustration of this, we may refer to *Lastrea dilatata*, plants of which occasionally produce from a single stipe two normal fronds. Taking spores from such a specimen, as has been done in the Botanic Garden here, and sowing them, the offspring does not, in the early state, exhibit the bifurcated rachis of the parent frond; although, as the plants increase in age, a few of them produce these abnormal fronds pretty

regularly; the majority of them, however, like their parent, produce them very irregularly. Spores having been taken again from the most regularly abnormal of these, we find that all the offspring exhibit the bifurcate fronds, the abnormal and normal being nearly equal. The plants are as yet, however, in a young condition, and will no doubt, as they advance in age, like their progenitors, produce with still greater regularity the abnormalities in question.

Before passing from this part of our subject, we would briefly direct attention to the agreement exhibited between the laws governing the inheritance of peculiarities in the Animal Kingdom, and those of the Vegetable. This law has been expressed in the following manner by an eminent naturalist, as obtaining amongst animals: "That at whatever period a peculiarity first appears, it tends to appear in the offspring at a corresponding age, *though sometimes earlier*."* To clearly exhibit the concurrence of the law of inheritance in plants with that admitted to obtain amongst animals, we must necessarily know at what period in the life of the individual the peculiarity first made its appearance. Another point must also be taken into account in considering the doctrine of inheritance at different periods—viz., that in each successive generation the peculiarity appears to be exhibited at a slightly earlier period. Hence an apparent objection might be raised against the doctrine, by taking the third or fourth generation reproducing an abnormality, which had originally appeared on a frond from an old plant. As in either of these generations, the peculiarity, as has been already shown in the case of the *Lastrea dilatata*, may have begun to make its appearance in the earliest stages of the plant's life. In those ferns, however, which have dissimilar barren and fertile fronds, should the variation not appear in the early stage of the plant's life, we are inclined to suppose that the variation in the offspring will be confined to the fertile fronds, the barren retaining their normal form. In illustration of this, we may mention the *Doodia media*, var. *corymbifera*, which produces with the greatest regularity, in the mature state, the characteristic, erect, densely-tufted fronds. In raising this

* Darwin's "Origin of Species."

fern from spores, however, we find that the young plants, which produce only barren fronds, differ little, if at all, from the normal specific form, having the same spreading habit. As they advance, the creting begins to exhibit itself on the lateral pinnæ, with a larger crest on the terminal; and they are usually two or three years old before the rachis begins to exhibit any ramifications. Occasionally, however, even in the mature state, as instanced by a plant in the Botanic Garden here, the normal barren frond is produced,—thus favouring the supposition that the variation has originated from a monstrous frond, produced by an otherwise normal representative of the species. Again, the *Blechnum Spicant*, vars. *crassicaule* and *cristatum*, on the other hand, reproduce with the greatest constancy, and, from the earliest stages, their characteristic, abnormal, sterile and fertile fronds. And the plants cultivated in the garden were perfectly abnormal when found, so that the early appearance of the abnormality in the young plants is readily explained, by supposing that the causes of variability have been called into action at an early period of the development of their original progenitors. These, then, are a few illustrations of the laws governing the inheritance of peculiarities in plants, as taken from our own observations, and we hope that others will be forthcoming, as we fully admit that there is an extreme paucity of evidence in support of these views; nevertheless, so far as we are aware, there is no evidence of a negative nature that has been brought to bear against them.

Having now briefly considered the relations of the fern-spore and plant, and indicated the probable cause of that peculiar power which the spore possesses for the reproduction of accidental variations, we will next proceed to consider the spore as a product of parthenogenesis. To substantiate our claim, however, for regarding it as such, it is necessary to show what grounds there are for the belief in parthenogenesis in plants, as of late the doctrine has been doubted, and even denied, by many botanists. It therefore becomes necessary, in hypothetically regarding the fern-spore as such, to furnish some positive evidence of parthenogenesis amongst plants. In using the expression "positive evidence of parthenogenesis," it is of

course only in the sense that a plant may be developed from a germ without any direct action of the male element. Professor Owen's theory of parthenogenesis may, or it may not, be true; it is sufficient for our purpose to give examples of the phenomena. And, indeed, by so doing, we substantiate a claim for the acceptance of the theory, as it can scarcely be denied that the inherited portion of the generative force—at least in the lower forms of vegetative life—is of too subjective a nature to exhibit any objective existence.

Accepting, then, the supposition alluded to in a preceding part of the paper, we regard the *spore* and its *immediate products* as parthenogenetic, satisfied that in so doing we shall have the most philosophically accordant explanation of the phenomena under consideration. And, by thus limiting the influence of the preceding generative act to the spore and its immediate products, *i.e.* the prothallus, antheridial, and archegonial cells, we invalidate an objection to the theory in its present application which has been thus expressed: "If the impregnation of the spore influences the whole future individual and its produce, would it be reasonable to expect the spores from an abnormal frond to reproduce in their offspring that abnormality?" The tenability, however, of this objection to the doctrine, even as originally applied, is very questionable, on a fair consideration of the results of parthenogenesis. It is well known that the offspring of parthenogenesis do not represent all the characteristics of the species, the male individual being always, so far as known, absent. Hence, the fact that female individuals alone are produced, demonstrates a modification in the inherited portion of the generative force, otherwise both would have been reproduced. And why, it may well be asked, may not the inherited portion of the generative elements in ferns also undergo a modification similar to the organs through which they have been transmitted, and thus admit of the reproduction of a similarly modified individual? In fine, we consider the latter view as much less gratuitous, though, as we before showed, insufficient for all the requirements of the case, than that which, regarding the *spore* as a *flower-bud*, must necessarily assume that the reproductive elements generated upon the prothallus, and which con-

sequently have had no objective existence in the parent, will nevertheless faithfully reproduce the characters of that organ of the parent they never had any immediate connection with.

The opinion, then, that the spore and its immediate products are the resultants of that portion of the generative force inherited from the preceding generative act, seems to be more fully accordant with observed phenomena than any other yet proposed. This hypothetical accordance will, however, be of small avail, if, as has been averred, parthenogenesis has no existence amongst plants. Such is the position assumed by Dr H. Karsten in his paper "On the Sexual Life of Plants and Parthenogenesis," in the Ann. and Mag. of Nat. Hist. vol. viii., from which we extract the following, being the conclusions which Karsten considers his investigations justify: "That all known species of plants possess, besides an asexual multiplication of individuals by cell-division or gemmation, a means of preserving the species by sexually developed germs, and that in these special reproductive organs a normal germ is never formed without the operation of a fertilising material; that, consequently, parthenogenesis never occurs in plants." Generally sweeping, however, as this conclusion is, it is far from being based on a general examination of all the known instances of parthenogenesis in plants. Dr Karsten undoubtedly proves that certain supposed cases of parthenogenesis were in fact true products of sexual generation, as instanced by *Cœlebogyne*, which produces at times hermaphrodite flowers; but there are other cases in which no such error of observation has yet been detected. Braun, in treating this subject, gives, besides the *Cœlebogyne*, a *Chara* in illustration of the doctrine. Karsten, however, in examining this paper, satisfies himself by exposing the errors of Braun's observations in the former instance, the latter being entirely ignored, which certainly is not a fair procedure in one who avers an anxiety for the discovery of the truth, and eschews the fallacious evidence of a preconceived interpretation. The example alluded to is, nevertheless, perfectly satisfactory, as may be seen by the following extract from the notice of Braun's paper in the Trans. Ed. Bot. Soc. vol. vi.:—"The *Chara crinita* is said to be diœcious, yet we seldom can detect

antheridia. Braun has in vain attempted to find these organs ; he therefore considers it as usually represented by female individuals, and that, nevertheless, it produces in abundance sporangia and fertile spores. M. Requiem has recently found male plants at Courtheson, near Orange, bearing antheridia. . . . Braun considers himself justified in attributing to *Chara crinita* the power of producing, at least in certain localities, without the action of male organs, perfectly formed spores fit for germination, and that, consequently, it is a true case of parthenogenesis." Another example has come under our own observation in the Botanic Garden here, where we have been successful in raising the Nardoo, *Marsilea quadrifolia*, var. *macropus*, from archegonial spores separated carefully from the antheridial, after the bursting of the primary receptacle, and before they had been acted upon by the spermatozoa of the latter, as the antheridial cells do not burst for several hours after the dehiscence of the primary receptacle. It is worthy of remark, however, that the germination of the archegonial spores, so far as our observations go, is much retarded by their separation from the other organs of the receptacle. This may partly be attributed, perhaps, to the mere chemical action, arising from the decomposition of the contents of the receptacle, which will no doubt have a tendency to accelerate the development of the unseparated spores, independently of the fertilising influence of the antheridial. Again, it has been shown by Duverney, that the archegonial spores of *Salvinia* are also capable of development, when separated from the antheridial. And this affords even a more conclusive instance of parthenogenesis than *Marsilea*, as the antheridial and archegonial spores of the former are contained in distinct receptacles, while in the latter they are contained in one.

These few examples, then, will, we trust, be sufficient for our present purpose, i.e., to substantiate a claim for the existence of parthenogenesis in plants. And, at a subsequent period, we hope to lay before you the results of a series of experiments instituted for the purpose of testing more satisfactorily the validity of this doctrine, which, according to Karsten, has lost its last insecure prop ; and who states " that the doc-

trine of parthenogenesis in plants is thrust aside, and it is established beyond doubt, that the production of a normal germ in the female organs is dependent upon the co-operation of the male organs of plants."

We will now proceed to examine the phenomena presented by the prothallus after the abortion of the archegonial cells. In a normal condition, the prothallus, after attaining a certain size, ceases to develop cells externally, and shortly after, from a point on its under surface, near the sinus, the primary frond is in general produced. At times, however, the prothallus, instead of producing the young plant, recommences a merely vegetative development, in a variety of ways. Thus, it at times increases by the development of cells at its circumference, attaining a large size, or it may produce a number of upright lobes, while in another these lobes are recumbent, the one overlapping the other. These, then, are the more common modes in which prothalli develop, the lobes in all these cases being very irregular, and indefinite in form. Instead of producing these indefinite forms, however, the prothalli at times exhibit a tendency to a "vegetative repetition of similar parts;" an example of which occurred under our own observation in the Botanic Garden here, where the whole surface of a prothallus became covered with minute granulations of green cellular tissue. These, on examination, were found to originate from the individual cells of the prothallus; each, however, retains its individuality, and now present miniature fac-similes of *normal prothalli*. In this instance we found no less than *forty* of these *secondary prothalli* developed from the surface of the single primary prothallus. In another example of this kind, which occurred on a prothallus of the *Asplenium obtusatum*, these secondary prothalli were confined to the circumference, forming a fringe around its margin. Another very anomalous appearance presented itself in the *Gymnogramma leptophylla*, of which we raised a fine healthy pot of prothalli in March 1861. These, however, having been inadvertently exposed to the direct action of the sun, were nearly shrivelled up before they were observed. Indulging a hope that they might possibly recover, we did not turn them out, but placed them in a

moist, shady situation, and found that, to a certain degree, this had the desired effect of restoring them. They, however, never regained their former appearance, and in a short time a gradual decay commenced from the circumference inwards, till at last we thought they had entirely died off. On examining a few of the dried-up and apparently lifeless remains of these prothalli, we were surprised to find that they had each produced a small, somewhat ovoid, cellular nodule. These nodules, or gemmoid bodies, appear to perform the functions of hybernacula, as, after a short period of rest, they each produced, in varying numbers, small tufts of narrow, erect, forked, marchantia-like processes. Whether these will ultimately produce young plants, or continue for a time a merely vegetative development, and ultimately decay, it is impossible, in their present condition, to say; and so far as our examination goes, there are as yet neither antheridial nor archegonial cells developed upon them. The late Professor Henfrey, in treating upon these points, remarks, "that after the abortion of the archegonial cells, the prothallus may again commence a vegetative development, but *will never produce young plants*." The latter opinion, however, does not agree with observed facts, as we have at present prothalli which recommenced this vegetative development some time ago, and from which young plants are now produced; and, we may also remark, that these are produced upon newly developed portions of the prothalli—thus demonstrating that the power of reproducing the plant *is* retained after the abortion of the primary archegonial cells. It must be borne in mind, however, that this has reference to those kinds of development alone where the original prothallus is increased by the development of cells around its circumference. As to the results of the other modes of development we are as yet ignorant, though it does not appear at all improbable that even these more anomalous prothalloid developments may likewise produce young plants.

Before concluding our remarks, we may briefly examine two other points connected with the subject we have been considering. First, the supposed incapability of the early spores of tree-ferns to germinate; and, second, the power which the fern-spore possesses of retaining for lengthened periods its

vitality. In regard to the first of these opinions, then, it has been observed by Dr Lowe, "that the early spores of tree-ferns are asexual, and incapable of germination." Following out this somewhat gratuitous opinion, Dr Lowe completes the fanciful analogy he has drawn between the organogenetic powers of the higher plants and ferns, by regarding these so-called non-fertile spores as similar to the *leaf-buds* of the higher plants. Thus, he remarks, "it is well known that young trees have a greater tendency to produce leaf-buds than flowers, and this may serve to explain why the earlier spores of tree-ferns are asexual, if we regard them as *leaf-buds*." "In later life," he continues, "the plant would naturally produce floral-buds, and these, of course, would be provided with sexual organs." This opinion, however, of the infertility of the early spores of tree-ferns, though thus given as an acknowledged fact, we cannot but regard as very doubtful, inasmuch as we have found no difficulty in raising various species of tree-ferns from the first spores produced by young plants. We may state, that we have succeeded in raising the following tree-ferns from these early spores, viz., the *Alsophila excelsa*, *A. Miquelii*, and *Hemitelia grandifolia*, all of which germinated freely. Again, the existence of those so-called "asexual spores" is disproved by the fact, that the first spores of the dwarfer kinds of ferns exhibit no such phenomenon, which they certainly ought to do were the view under consideration correct. And we have experimented on spores from very young plants. Amongst others which we have tried, we may mention *Asplenium Shepherdii*, *Athyrium Filix-femina*, and *Lastrea dilatata*, all of which, as is well known to the fern-cultivator, exhibit a tendency, even in the youngest fronds, to produce spores. These, then, like those produced on the early fronds of the more noble representatives of the order, are theoretically asexual, as they must be regarded by the supporters of the preceding analogy as occupying the same position amongst ferns that the perennial shrubby plant does amongst phænogams.

These experiments, however, have been considered as inconclusive, on the ground, that as restriction of the roots has a tendency to produce the more early production of floral-

buds, so in the case of ferns grown and restricted in pots, they, as a natural consequence, will produce the homologue of the floral-bud—the perfect spore. This, so far as regards the mere production of spores—in tree-ferns at least—is quite correct, as we observe Professor Balfour, in his “Class-Book of Botany,” in remarking on the rare occurrence of fructification in fossil-ferns, directs attention to the tree-ferns of the present era, whose fronds rarely exhibit fructification, as affording, in all probability, an explanation for the rare occurrence of fructification in fossil ferns. In admitting this, however, we do not at all invalidate our experiments, seeing they were made upon the *earliest spores* produced by the young plants, consequently they ought to have been the “asexual” productions, if such are ever produced, and of which we have already expressed our doubts. In fine, the non-germination of the spores in the experiments—which we suppose have been made—may be due to unsuitable physical conditions, as has been well shown by an experiment in point made in the Botanic Garden here. Mr M’Nab had been repeatedly unsuccessful in his attempts to raise the *Cyathea arborea* from spores taken from a fine old plant in the stoves. These experiments were tried in a mean temperature of 60° Fahr. From the success attending other experiments which Mr M’Nab had been repeating in higher temperatures, he was induced to try the spores of the *Cyathea arborea* with an increase of temperature likewise. They were accordingly placed in a moist, shady situation, in a mean temperature of 75° Fahr. The experiment proved perfectly successful, as in fourteen days, by the aid of the lens, the spores were all seen to be in a germinative state, and at present there are plants in the stoves raised from them. Thus we have an instance which might have induced the less demonstrative theorist to conclude at once that these spores were imperfect “asexual” productions, without for a moment considering that their so-called asexuality might be a consequence of uncongenial physical conditions. And therefore we consider ourselves justified in regarding the non-germination of the early spores of tree-ferns, in the experiments we presume to have been made, as due to accidental causes, such as unsuit-

able physical conditions, immaturity of the spores; or, perhaps, the bursting of the spore-cases, and escape of the spores before the former were committed to the soil. These, then, are a few of the probable causes that may afford an explanation of the opinions we have been considering. But whether they do so or not, our experiments nevertheless demonstrate that there is no generally recognised law in the economy of the tree-ferns warranting the acceptance of the view, that *asexual spores* precede the *sexual* in the life of the individual.

2. In regard to the capabilities of spores retaining for lengthened periods their germinative powers, little information is at present to be found. Indeed, so far as we are aware, the only instance on record is that mentioned by Professor Balfour, in his "Class-Book," p. 628, where it is stated, that "two plants of *Gymnogramme calomelanos* were obtained from spores which were taken from the Herbarium of Forster, and were about fifty years old." We, however, have been less fortunate in our attempts to raise ferns from spores taken from Herbaria, though we have experimented on a large scale. Having taken spores from upwards of two hundred species, from the University Herbarium here, the dates of which varied from 1827 to 1859. Amongst these we observe the *Gymnogramme calomelanos* occurs twice, bearing respectively the dates 1827 and 1844. From neither of these spores, however, did we succeed in raising a single plant of the *G. calomelanos*, though a few other ferns came up in the pots. This was, indeed, the case in the majority of our experiments; but not a single instance occurred of plants of the species labelled being produced in their respective places. The growth of other species of ferns in the pots took place, though the greatest care was taken to exclude all other spores, each pot being covered immediately after the spores had been sprinkled on the surface of the soil. May this not have been the case in the example of the *G. calomelanos* raised from old spores? We are much inclined to suspect that the *Gymnogramme* may have been produced from the accidental introduction of recent spores amongst the old ones; more especially because *it*, and other species, are perfect weeds in

the stoves where they are grown, springing up wherever a suitable *nidus* presents itself. Indeed, it is difficult otherwise to understand the complete failure in the numerous experiments we have made for the purpose of determining the vitality of fern spores, as these were taken from fronds in an excellent state of preservation, and the conditions they were placed in were fully sufficient to have called into action their dormant vitality, had they possessed the power of retaining it. In fine, the numerous unsuccessful experiments we have made on this point certainly justify us in concluding, that the spores of ferns do not retain their germinative power for any length of time in the ordinary conditions of Herbaria. What their capabilities may be for retaining *it* when buried in the soil, we cannot at present positively say, though it would appear, from experiments now pending, that they, like certain phanerogamic seeds, may retain this power for long periods.

On the Origin of Aerolites. By MRS G. S. SILLIMAN. Communicated by the Authoress.

Fragments of stone of a peculiar character, not identical with any telluric masses, are known to have fallen from the atmosphere upon the earth for more than two thousand years. They have come from fire-balls careering in the clear sky both in the day and by night, and also from small, very dark clouds, which suddenly threw down showers of stones like hail. These were dissimilar in size, appearing to have been shattered and crushed in the fall, but possessing a thorough identity of constituents with those which fell from the meteor or fire-ball. In their original condition they are invested or coated by a crust or rind peculiarly characteristic of these bodies, being only a few lines in thickness, often glossy and pitch-like, and sometimes veined. This black crust, though adhering closely, is divided from the inner light-grey mass by a sharply defined line of separation.*

Biot states that we are indebted to the all-registering

* Humboldt, Kos. i. p. 118. The peculiar colour of the crust was observed as early as the time of Pliny.

Chinese for the record of the most ancient aerolites, and he enumerates sixteen falls between years 644 B. C. and 333 A.D. They have fallen in India, in Siberia, in Greenland, and in many parts of Europe and America. The most remarkable one of antiquity fell at Ægos Potamos, in Thrace, 400 years B.C. It is stated in the *Parian Chronicle* that it was the size of two millstones, equal in weight to a full waggon load.*

The largest masses have been seen to fall from fire-balls, or single meteors, moving swiftly in the clear sky, accompanied by flashing light and a report like prolonged peals of thunder. The aerolite which fell in Weston, in Connecticut, in 1807, excited no common attention. A reliable witness† of it told the writer that a flashing light and the noise of a crashing fall a few feet from the place where he stood, drew him to the spot, where he found broken pieces of stone quite hot, and instantly the report followed like thunder. Two or three miles beyond this first fall, several more fragments were deposited within the area of a mile. The largest piece fell in a ploughed field, and was nearly buried. It weighed 36 lbs. Other pieces descending on pasture ground, and two, in particular, on a grassy door-yard, did not penetrate below the surface.‡

When aerolites have fallen from small, very black clouds, like showers of hail in variously shaped, often angular, fragments of all sizes, they have been accompanied with flashing light and rattling reports like artillery. Such were those seen in the Department of Ardeche, in France, also in the Llandes, and at Alençon and Aisne.§

The ancients were not indifferent observers of these surprising phenomena. They proposed a great variety of theories and hypotheses accounting for them. Among many others, Anaxagoras of Clazomena, and Diogenes of Appolonia, thought they were projected from dark invisible bodies or stars moving in space. According to Diogenes "invisible masses of stone move with the visible stars, and the former sometimes fall

* *Par. Chron.*, 113 of the Attic era.

† Merwin Burr, Esq,

‡ The pieces discovered were estimated at three hundredweight.

§ In this instance there fell upon an elliptical surface, whose major axis had a length of six miles, a great number of meteoric stones, the largest of which weighed seventeen and a-half pounds.

upon the earth."* The Greeks, more distinguished for fertility of imagination than for patient and thorough inquiry, after the fall of the great Thracian aerolite adopted the views of Anaxagoras and Diogenes, as did the Ionian school before the close of the Peloponnesian war. This opinion prevails to some extent at the present day; while some imagine that the stones fall from terrestrial satellites, some that they come from the moon, some that they are projected from volcanoes, and others that they proceed from invisible comets revolving in very elliptical orbits; that when approaching the earth they fall within its atmosphere, and by the friction of the air become heated and electrified; that then the electricity is discharged and sends off a portion of the mass, and the comet pursues its way into the regions of space. By many it is believed that they are foreign to the earth, and fall upon it from some other sphere. Humboldt suspects that "they may come from some crumbling asteroid, because the solid mass could not instantly run together from any known state of gas or vapour, and because their motions have been observed to be opposite to the rotatory movement of the earth.† Kepler is one of the few who dissent from these and similar hypotheses. With such an example, and a few of modern date, I may without temerity entertain different views from those generally received.

It seems not in accordance with ascertained science to ascribe mysterious appearances on the earth, or in its atmosphere, to causes proceeding from planets, or spheres moving in space, *independent* of the earth and its system. Looking into unknown regions for subtle and complicated causes will not be likely to unveil mysteries; for, "when revealed, those mysteries are always found to be the result of a few simple, invariable laws."‡ It has been said truly, that "the only media by which we are brought in connection with any portions of the universe beyond our atmosphere are light and heat."§ The question then arises, whether the elementary materials and chemical processes which originate meteorites

* Humboldt, Kos. i. p. 569. Stobæus Ency. Phys. p. 503.

† Kos. i. p. 237.

‡ Sir John Herschel, *System of Astronomy*.

§ Kos. i. p. 125.

do not all exist and act in our atmosphere. If masses of solid matter descend upon the earth from other planets, satellites, or asteroids, would not the *position* of the earth, after receiving such additions, be altered in space? Would not its course deviate from its primary orbit in the progress of ages? Would it not interfere with, and ultimately come in collision with, some of the heavenly bodies, destroying the harmony and stability of the system? It has been replied, that the quantities are so inconsiderable that the added weight would be inappreciable. If not at once appreciable by our senses, would there not be in process of time a failure in the astonishing accuracy with which the planetary motions are fulfilled in space, even to the fraction of a moment? Would not the added weight from other spheres be sufficient to sway a globe poised with *infinite* exactness? The accumulated weight in long periods of time must be much greater than appears on a slight or hasty view of the subject.

Meteors cannot be, as some imagine, astronomical phenomena. Their *erratic character* is a conclusive test that they are not. The movements of the heavenly bodies are certain, regular, and strictly periodical, while the movements of atmospheric bodies are uncertain, irregular, and only occasional. In striking contrast with the solemn certainty and grandeur of the heavenly bodies are the fleeting fugitive motions of the dark meteoric stone. The sun, moon, planets, constellations, comets, are all obedient to *periodical law*. Their times, and circuits, and motions, are defined by the most rigorous mathematical computations; and they fulfil their rounds with hairbreadth precision, far above and beyond the fickle currents, the forces, attractions, and affinities, wavering in the atmosphere.

"The fall of meteorites is much more frequent than is generally believed. Great numbers must fall in the ocean, and on uninhabited parts of the land unknown by man."* Doubtless as many have fallen through all past ages upon this continent as upon the old world, where over our past wildernesses, and lakes, and rivers, and oceans, there was no eye to see them. If a trapper or an Indian had been awe-struck by the pheno-

* Connection of the Phys. Sci. p. 312.

menon, he had no way to communicate his astonishment; there was no auditor to comprehend or remember them, nor hand to record them. Pliny describes the fall of meteoric stones as being "*frequent*;" and, in more modern times, Olbers states, "that it appears probable, from the researches of Schreibers, that there are about 700 falls annually." In the great Italian shower at Crema, in 1663, Cardenas affirms that "1200 fell; that one fragment weighed 120 lbs., and was of an iron-grey colour." The stones were of all sizes, and the cloud from which they fell of uncommon blackness and thickness.* Many more cases might be cited of their existence in the Arctic and Tropical regions, and in every part of the world, but always known, wherever they are found, by the presence of nickel and iron, which combination does not exist in telluric rocks. Would not the aggregate of all these masses, known and unknown, displace the almost invisible fibre by which the exactness of planetary motions is computed?

As the constituents of aerolites are identical with minerals and metals found on the earth, *though the combinations are different from any terrestrial masses, it is rational to search for their formation among the agents and forces known to exist within the earth's system.*† Is not magnetism, with other known agents, and the power of chemical action, sufficient to attract and consolidate meteorites with their accompaniments, as fireballs, fiery meteors, or very black clouds, from which they are precipitated upon the earth? It is a fact to be remembered, and one of great importance, that meteorite stones in all zones, and wherever found, have the same phy-

* Kos., iv. pp. 588, 589.

† The recent study of those wide-spread atmospheric accumulations of meteoric dust—a single case being recorded where the area must have been thousands of square miles in extent, and where the quantity of earthy matter must have been from 50 to 100,000 tons in weight—makes known to us the vast scale on which terrestrial matter often pervades the regions of the upper atmosphere."—*Shephard's Report on Meteorites.*

"According to Biot, clouds of metallic dust are retained in those remote distances."—*Idem.*

"Showers of dust sometimes accompany and follow the fall of aerolites, which are a fine impalpable powder, whose chemical composition corresponds with that of meteoric stones."—*Idem.*

siognomic resemblance. Perhaps it is not second to that other fact, that the presence of iron and nickel combined in them is an unailing criterion of their meteoric character.

Professor Faraday (on Atmospheric Magnetism) states, that "magnetic power emanates in lines of force from the earth, rising into the atmosphere, which is in reality a magnetic medium, where it is ever present in greater or less degrees of intensity, completing in the air its circuit of power." Iron and nickel are peculiarly susceptible of magnetic attraction. They are invariably associated in meteorites; they are "always present in them, if amounting only to an alloy, and are an especial criterion of the meteoric nature of the mass." According to Berzelius, "many specimens of meteoric stones contain other metals and earths; in all one-third of the simple substances known, and the same which are met with through the crust of the earth;" and it is a striking fact, that no strange or anomalous substance has ever been found among their constituents—nothing but specimens known to be of terrestrial origin. Magnesia constitutes commonly one-half of the earthy constituents of the meteoric stone. Water is ever present in the atmosphere; also magnesia, carbon, sulphur, iron, nickel, and other metals and earths in a state of vapour, or gas, or dust.*

In the various analyses of aerolites, *silica* is a prominent constituent. Whether it is raised mechanically in dust, or in its soluble state, and how it performs its part in the mysterious compound, is a problem for further inquiry.†

Silicic acid united with oxide of iron and magnesia, or other earths, forms rocks differing in character, according to their quantitative proportions.‡ Sulphur and sulphurous acid must

* Ehrenberg says, that the dust region in the atmosphere is of vast extent.

† In April 1719, there fell into the Atlantic Ocean, in N. L. 45°, a shower of sand, preceded by a luminous meteor. No volcanoes on those coasts."—*Certified by the Captain and Crew of a vessel to Father Feuilles*, Ed. Encyc.

A shower of sand accompanied a fall of small stones at Cazone.

Certain it is, that sand was mingled in the Sienna meteorites, thus pointing to an intimate connection between *silex* in the loose and in the consolidated state.

‡ "When water is cold it contains carbonic acid in solution, and then decomposes many minerals—even those which appear unalterable, such as hornblende, feldspar, &c. Combined with heat and pressure, it will dissolve sand,

be among the active agents in the meteoric aggregation, as the odour of sulphur is always present when the meteor falls, and sulphur is generally found to be one of its constituents. The masses vary in solidity and compactness; some being weakly coherent and porous, others sprinkled with metallic specks and rounded oval grains; and while some resemble grey porphyry, others again are very hard and refractory, such as the meteoric iron masses.

When it is considered that there are ponderable substances in the atmosphere—that it is laden with thousands of bodies foreign to its component parts—it may be inferred that nickel, iron, and other metals, with the various earths, are magnetically and chemically attracted and consolidated in the air. The atmosphere itself, though always the same in its composition, is not always in the same state; not always equally attenuated at corresponding elevations; not always calm nor always disturbed at the same altitudes; it varies with the effects upon it of many agents that are not understood, and is subject to many phases that have not been accounted for. But it is known to sustain heavy bodies. These fall to the earth when, by their inherent properties, or the sudden action of heat, or some explosive or other force, the power which had upheld them is overcome. Humboldt remarks: "There is something strange about them (meteorites). The combination of the elements is unlike all that our terrestrial mountain and rocky masses exhibit." Hence it is obvious that they are formed in a different medium, and not on the earth or under the sea. Although the constituent parts are often identical with many mountain and rocky masses, yet they bear the impress of atmospheric laws, and show that they have not been elaborated by heat under pressure, nor by sedimentary deposits from floods, *but by the action of chemical affinities, magnetic attractions, and other invisible forces in the FREE AIR.*

one of the most insoluble of substances. The chemical reactions occurring in waters holding different compounds in solution would account for many changes, and the action of exhaling gases from the earth must exert a decided influence."—*Silliman's First Principles.*

"Phosphoric and titanitic acids have been detected in aerolites by Rammelsberg."—*Ann.* 83, p. 337.

If the elements are attracted and combined by magnetism and chemical affinities, elevated and moved by elastic vapours and aerial electricity, the mass may be suspended in part by its form and by the upward pressure of the atmosphere ; if it is an inflated, hollow sphere, then in part by its contents, and possibly in part by the occult forces which take up and convey heavy bodies in the black cloud of a tornado. The suspension of a meteor in the air can cause no surprise when the ascent of a balloon with men and horses and other ponderous substances is not found impracticable.* The meteor has this great advantage : it depends on no *artificial adjustment*, but all the materials, affinities and forces requisite for its aggregation, suspension, and ultimate explosion and descent, are present in the free air, with an energy not attainable by man. The irregular convexity of surface which marks many meteoric stones indicates that the masses were globular when entire, and if globular, it is further evidence of atmospheric combination ; because all fluid and plastic substances assume spherical forms if suspended in the air ; and these masses were doubtless plastic, though not probably fluid, in the incipient stage.† Their internal constituents appear to have been primarily aggregated without the influence of heat. Even the rounded globules found in many of them bear no mark of fusion, but “are evidently dependent on a cause analogous to that which determines the configuration of hailstones.”‡ Some are soft when they fall,§ impressible like putty, and harden by exposure to the air ; but almost all the specimens, when found, seem to have been rent by explosions, which suggest that there was a cavity or cavities in the mass, containing water, perhaps hydrogen or other expansive vapours.

Chemical action evolves electricity. Electricity is a source of heat. It appears as though a sudden electro-magnetic action,

* “Bodies in air lose a part of their weight.”—*Silliman's First Principles*, p. 214.

† “They have in general a *spherical figure*, in which we often observe indentations.”—*Ency. Amer.*, vol. viii. p. 439.

‡ Professor Shephard's Report on Meteorites.

§ As at Barbotan—*Ency. Ed.*, p. 138 ; and at Scriba, N. Y.—*Shephard's Report*, p. 20.

or perhaps it were better to say a meteorological process evolving heat, spontaneously igniting and fusing the gaseous materials and vapours which were collected and slumbering around the exterior of the mass, by its flashing fires, produces the thin, dark coating which invests them all. "The dark crust must be the effect of a powerful, though momentary heat; for the sulphurous and metallic particles immediately beneath it do not change colour or lose their lustre." By the same process, and at the same time, it is most probable that the mass is suddenly heated enough to expand any explosive contents enclosed in it, kindling the vapours and gases, swelling and rending the bubbling meteor, and with tornado energy hurrying its swift descent to the earth.* Who has analysed the fierce cloud of the hurricane, or the sullen simoom, or the resistless power which lifts and conveys heavy bodies on the dark wing of the tornado? These phenomena are seen in these lower regions of the air; yet the tremendous chemical action, the attractions and affinities making up the meteorological processes in them and in the upper air, are unexplained. The gain of knowledge, however, thus far obtained, almost gives assurance of further revelations.

Much has been done and is doing to measure and ascertain the deposits, deep-sea currents, and drifts of the ocean, and their influence on the earth and air. The great atmospheric ocean, with its mysterious phenomena of intense interest, this age of inquiry cannot fail to explore.

It is maintained by some that the meteor is a large body traversing the heavens, and that after disengaging fragments of itself, and shooting them off to the earth, it moves on, revolving around the planet, or pursuing its way into the regions of space. But has the main body of the meteor ever been seen after the explosion? In all the descriptions given by eye-witnesses of the many falls contained in the accompanying catalogue, not one has ever seen the meteor "*travel on.*"

* "Chemical rays of light may have some part in this matter; for, by their action on chlorine and hydrogen gases, they are made to combine with explosive energy."—*Silliman's Chem.*, p. 50.

It has been long known that the direct rays of the sun would cause the explosive union of these gases.

The general remark of those who saw the fall, or who were near at the time, has been, "*it fell and went out,*" or, "*it vanished.*" Must it not be believed that the whole body, be it more or less, fell to the ground when it exploded?

Among many very striking incidents which might be cited favouring this inference, is a letter from Maurice Crosby Moore, Esq., of Moore's Fort, near Limerick, county Tipperary, giving conclusive evidence of the descent of the entire mass to the earth.

"In May 1810, some workmen laying leads on the roof of my house, between 11 and 12 o'clock A.M., heard a strange noise, and thought the chimney was on fire. On looking up, they saw a small black cloud, very low, carried by a current contrary to the mass of the clouds. It flew with great velocity over their heads, and fell in a field three hundred yards from the house. *They saw it fall.* The stone was immediately dug up, carried to the steward's house, and remained two hours cooling before it could be handled. I saw the hole it made in the ground, not more than a foot in depth. It weighed $7\frac{1}{2}$ lbs., and the entire surface was covered with a thin, brownish-black crust, evidently the effect of a rapid heat."* The other particulars of this account, even the rounded globules contained in the stone, and the analysis showing it to be a genuine aerolite, are here omitted for the sake of brevity. The incident is quoted for the evidence it gives in the full light of day, that the *whole mass fell*, and no remainder "travelled on."

The projectile force of the explosion must direct the course of the meteor, which may or may not conform to the earth's rotation. Its course being opposite to the earth's rotation, is therefore no token that it came, as Humboldt imagines, from a "crumbling asteroid."

Many of the computations regarding the immense height from which meteorites are supposed to fall may be erroneous; but if not, and the formation of the meteor takes place in the upper air, where it is supposed that the great accumulations of meteoric dust are, it still more favours the theory of their

* Edin. Encyclopædia, xiii. p. 149.

atmospheric origin. Their altitude may be far beyond reach of our vision before the descent commences.

It seems to be no valid objection to the atmospherical combination of aerolites that "they cannot instantly run together from any known state of gas or vapour."* It does not follow that the time required to form the aggregation must be instantaneous because its appearance is sudden. The meteor may be long in forming, though the flashing light and the thunder of the explosion give the first notice of its existence to the inhabitants of the earth. The fall of showers of stones from pitchy clouds, in thousands of irregular, often angular-shaped fragments, indicates that they are broken by explosion; and their constituent parts being the same as those from fire balls, or single meteors, identify them as meteoric stones. The lightning flashes and reports, sometimes like musketry and artillery, at others like long-continued thunder, add presumptive evidence that they are combined in the air.

In reviewing this subject, it is seen that this phenomenon awakened the attention of the ancients more than two thousand years ago. It has caused every eye-witness to wonder and pause, from Greenland and Siberia to sunny Italy, Greece, and Spain. In the middle ages it excited religious terror and superstition, as being portentous of dark vicissitudes and public calamities. In these later times men discard the gloomy imaginings of the past, and are diligent in divining and investigating its origin and cause,—seeking its advent here from distant planets or the regions of space,—from "crumbling asteroids" and invisible satellites. Science has removed the dim but fearful shadows that hung over the student of nature, obscuring his way. By the clear revelations and facts now before him, he ventures upon hypotheses which, if only probable, may open the way for brighter light to beam upon the future inquirer.

In view of the attracting and forming powers and forces known to exist in the atmosphere,—the gases, the acids, the dust, the chemical affinities, the great solvent *water*, electricity, and magnetism, all present in the free air, and all acting conformably to the laws and properties made inherent in

* Humboldt, *ut sup.*

them by the Creator,—is it not more in harmony with the integrity and perfection of His works that this phenomenon should originate in a meteorological process, than that the symmetry of the creation and the order of the planets should be violated by a visit to the earth of a lone, foreign intruder from the depths of space, or from some other sphere, without analogies or any apparent purpose?

The following catalogue is compiled principally from the "New Edinburgh Encyclopedia," vol. xiii., and the Chronological List in the first volume of the "Edinburgh Philosophical Journal," consisting of Cladnis' printed catalogue and a MS. list by Thomas Allan. The remainder has been derived from sources equally reliable, and every instance named is believed to have been that of a true and unmistakable Aerolite.

Chronological Table of Aerolites.

- B.C.
1478. A stone fell in Crete. Regarded as the Symbol of Cybele.—*L. 18, 19, Chronicle of Paros.*
1200. Also one in Orchomenos.—*Pausanias.*
1168. A stone fell on Mount Ida.—*Chron. Paros.*
750. The deity which fell down from heaven, worshipped by the Phenicians, was a large black stone, not polished by hands, circular below, and terminating in a cone.—*Herodian.*
705. The Ancyle, or sacred buckler, fell from heaven in the time of Numa.—*Plutarch.*
670. A shower of stones fell in the days of Tullus Hostilius. "Was solemnly celebrated as a supernatural occurrence."—*Livy.*
654. "The earliest historians of China make mention of stones falling from heaven."—*De Guignes.*
491. A stone fell in Crete.—*Calmét.*
466. The famous aerolite of Aegæ Potamos was the wonder of all the countries of Greece, and was exhibited by the people of the Chersonesus, who held it in the greatest veneration, and deemed its fall an omen of victory.—*Plut. Life of Lysan.* vol. iii. p. 100.
463. A stone fell in Ancona; also one near Thebes.—*Val. Maz. Schol. Pind.*
461. A shower of stones in the marsh of Ancona.—*Liv. lib. 7, c. 28.*

B. C.

343. A shower of stones fell near Rome.—*Jul. Osequi.*
 211. A stone from a meteor in China.—*De Guignes.*
 205. Fiery stones.—*Plut. Fab. Max.*
 205. A fall of stones in Ancona.—*Livy.*
 204. A stone of a dark hue and metallic aspect fell in Pergamos. Was worshipped as a sacred idol in Rome.—*Plut. Fab. Max.*
 206. A shower of stones; and
 196. Several large stones in China at nineteen } *De Guignes.*
 different falls.
 176. A fall of stones in the Lake Mars.—*Livy*, xii. 3.
 56. Spongy iron in Lucania, and a shower of stones at Acilla in Africa.—*Cæsar.*
 38. Six stones,
 29. Four
 22. Eight
 12. One
 9. Two
 6. Sixteen
 " } Fell in different provinces in China.—*De Guignes.*

A.D.

452. Three large stones fell in Thrace.—*Chromion*.
501. A shower of stones at Bender, in Arabia.—*Procopius*.
501. Two stones from a globe of fire on Mount Lebanon.—*Proust*.
823. A shower of pebbles in Saxony.—*Mezeray Bonaventura*.
852. Stones fell in Tabristan and Chenan in Japan.—*De Sacy*.
855. Five stones fell in Egypt.—*De Sacy*.
905. Stones fell in Japan, also in Ahmedadab, and at Hoang Lee, in Corsa.—*Quatremere*.
998. A very large stone fell near Augsburg.—*Albertus Stabius*.
1009. A fall of stones near Magdeburg, and one near the Elbe; also one in Cordova.—*Avicenna*.
1021. A number of stones fell in Africa.—*De Sacy*.
1135. Large stones were precipitated from the air in Thuringia.—*Spangenburg*.
1198. Stones fell near Paris.—*Henry Panvel*.
1249. The descent of stones from the sky was remarkable in various parts of Saxony.—*Spangenburg and others*.
1263. Stones fell at Wieloxoi, Russia.—*Gilbert, Annalen*.
1280. A large stone in Alexandria, Egypt.—*De Sacy*.
1304. Oct. Many stones fell in the fields in Saxony, doing much damage near Friedland.—*Krantz*.
1305. Burning stones fell in the country of the Vandals.—*Bona-ventura St. Amable*.
1328. In Mortchia and Hoang Lee.—*Quatremere*.
1368. Stones fell from the clouds in Yorkshire.—*Phil. Mag.*

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1379. Stones fell at Minden in Hanover.—*Lerbecius*.
1438. Stones fell near Burgos, Spain.—*Proust*.
1480. Stones fell in Bohemia and Saxony.—*Phil. Mag.*
1480. The fields were strewed with stones.—*Proust*.
1491. A fall of stones near Crema.—*Simmut*.
1492. On Martinmas eve fell the remarkable stone of Ensishieme, near Torgau, weighing 260 lbs. It was placed in a church as a miracle. Now in the library at Colmar.—*Trithemius*.
1496. Three stones fell between Cesona and Bertonari, also a shower of stones.—*Sabellicus*, p. 341.
1510. A Carthusian monk saw the fall of about 1200 stones in a field not far from the river Adda, in Milan. One of them weighed 120 lbs., one 60 lbs. &c. &c.—*Gardenas*.
1511. Stones weighing 8, 11, and 9 lbs. each fell at Crema.—*Giovanni*.
1516. Sixteen globular stones fell in the province of Yoi tchouan, weighing 16 lbs., 27 lbs., &c. &c., to 1 lb. each; and in
1520. In May, stones fell in Arragon.—*Diego de Sayas*.
1540. A large stone fell in the Limousin.—*Bonaventura St. Amable*.
- 1548 to 1552. Stones fell in different parts of Thuringia, making much havoc near Schliessingen.—*Spangenburg*.
1559. At Miscoltz in Transylvania "five stones, large as a man's head, fell from the heavens."—16th vol. *Breslau Collection*.
1560. Stones fell in the Torgau.—*Gesner and de Boot*.
1580. Stones fell in Gottingen.—*Bange*.
1581. "A stone weighing 39 lbs. and very hot, fell in Thuringia, from a serene bright sky, with an explosion, from a globe of fire."—*Birchard's Chron.*
1583. March. A stone of the size of a hand grenade fell in Piedmont. In June one of 30 lbs. weight, resembling iron, fell at Rosa in Livadia.—*Casto Mercati*.
1596. A stone fell in Valencia in Spain full of metallic veins.—*Cesias, the Jesuit of Coimbra*.
Large stones fell at Kunnendorf.—*Annales Marchi*.
1596. Stones fell at Crevalloore.—*Mettarelli*.
1618. A great fall of stones in Styria.—*De Hammer*.
1618. A metallic mass fell in Bohemia.—*Kronland*.
1620. A large body of iron fell in the Punjaub in India. The Emperor Jehangire had made of it two swords and a dagger.—*Jehangire's Memoirs*.
1622. A stone fell from the sky in Devonshire.—*Rumph*.
1628. A stone, 24 lbs. weight, fell in Berkshire, England.—*Gent. Mag., Dec.*

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1634. Stones fell in the Charollois.—*Marinus*.
1636. A burnt stone fell in Silesia.—*Lucas*.
1637. Stones fell in Vago, at Calce, and at Saga, in Silesia ; also one in Provence, which was *spherical*, and fell from a fire-ball ; its weight was 54 lbs.—*Gassendi*.
1637. Near this date fell on the ground of the Benedictines, near Verona, a very large stone, broken into many pieces, some 3 feet long.—*Gassendi*.
1642. A stone weighing 14 lbs. fell near Woodbridge in Suffolk.—*Gent. Mag.*
1643. Stones fell in the sea.—*Wurfhain*.
1647. A stone fell near Twickgau.—*Schmid*.
1647. Stones fell in Westphalia.—*Gilbert, Annalen*.
1650. A large stone fell at Dordrecht.—*Singuisd*.
1653. A stone fell into the sea.—*Malte Brun*.
1654. A shower of stones in the Island of Funen.—*Bartholinus*.
1654. A large stone fell from the atmosphere at Warsaw, Poland.—*Pet. Borellus*.
- 1654-5. A stone fell at Milan, killing a Franciscan monk.—*Musi, Sept.*
1668. A great fall of stones near Verona, weighing 800 lbs. and 200 lbs., &c.—*Vallinieri*.
1671. Stones fell in Swabia.—*Gilbert, Annalen*.
1673. Two large stones fell in the canton of Glarus.—*Scheuzer*.
1674. Stones fell in a field at Dietling.—*Leonardus*.
1675. A stone fell on a boat in the Orkneys.—*Gent. Mag.*
1676. March 26, O. S. A fire-ball came as if over Dalmatia, obliquely to Leghorn, where it exploded, and the fragments fell into the sea with a hissing noise. The meteor appeared as large as the full moon at Bologna.—*Montenari's Report*, No. 312, *Gent. Mag.*
1677. Stony masses fell in Calabria and in Saxony.—*Misi*.
1680. Stones fell in London.—*King*.
1697. Stones fell from the sky in Sienna.—*Transactions Acad. Sc., Sienna*.
1698. Black stones fell with many explosions in the canton of Berne.—*Scheuzer*.
1706. June. A stone weighing 76 lbs. fell from a small dark cloud at Larissa, Macedonia.—*Lucas*.
1719. A shower of sand fell in the Atlantic, N. L. 45°, preceded by a luminous meteor. The captain and crew of a vessel certified the fact to *Feuillee*.
1722. June. Stones fell near Scheftlas, in Friesingen.—*Mirchelbirk*.
1723. Thirty-three stones fell from a small black cloud in Bohemia.—*Breslau Collection*.
1727. Stones fell at Lilaschiltz, Bohemia.—*Stepling*.



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1738. Stones fell at Carpentras.—*Castillon*.
1740. Stones fell at Rasgrad.—*Gilbert, Annalen*.
1741. A large stone fell in Greenland.—*Egede*.
1743. Stones fell at Liboschitz, Bohemia.—*Stepling*.
1750. A large stone fell at Niort, near Coutance.—*Lalande*.
1751. May 26, at 6 o'clock in the evening, a remarkable fire-ball exploded in Upper Sclavonia. A stone fell from it and broke in two pieces; one part weighed 71 lbs., the other 16 lbs.—*Klaproth*.
1753. A stone fell in Eichstadt.—*Cavallo*.
1753. Four large stones fell in Strokow, when the air was perfectly tranquil and the sky a little shaded with fleecy clouds. Their fall was preceded by three long, loud peals of thunder, or more like the rattle of artillery. A specimen remains in the Cabinet of Vienna, and one in the Bosnian Collection.—*Analysed by Howard. Reported the year after it fell by Stepling*.
1753. In September. Two spherical stones, one of 20 lbs., the other $11\frac{1}{2}$ lbs., fell near the village of Liponas, preserved in the Cabinet at Dijon. They fell from a clear sky, with loud explosions like the successive discharge of cannon.—*Lalande*.
1755. A stone fell in Terra Nuova, Calabria, weight 7 lbs. 7 oz.—*Domin. Tata*.
1766. In July, from a clear sky, at Albareto, near Milan, a large, dark, burnished stone fell with a whizzing noise and the sound of artillery.—*Troili and Vassali in Physico-Meteorological Letters*.
In August a stone fell at Novellara.—*Beccaria*.
1768. November. Stones fell near the Castle of Luce in Maine.—*Memoir Acad. Paris*.
1768. A stone fell near the Inne in Bavaria with a hissing noise; weight 38 lbs.—*Imhof, in Gilbert, Annalen*.
1768. A stone fell at Lena, in Arragon, of an irregular spherical shape, and covered with a dark vitreous crust common to aerolites. It was extremely porous, and was composed of rounded oval grains, scarcely larger than hemp-seed, among which were sprinkled metallic particles and sulphur. The stone is preserved in the Royal Collection at Madrid.—*Proust*.
1775. Stones fell in Rodach near Cobourg.—*Gilbert, Annalen*.
1776. Stones fell in Volhynia.—*Gilbert, Annalen*.
1776. A great shower of stones fell in the ancient Duchy of Camarino.—*Soldani*.
1777. Two stones fell in a meadow in Westmeath, Ireland.—*Gent. Mag.*

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1780. Stones fell in Beeston, England.—*Lloyd's Ev. Post.*
1782. A large stone fell near Turin.—*Tata.*
1785. September. In Eichstadt a brickmaker saw several stones fall, accompanied by a loud peal of thunder. He ran to take hold of one, but it was so hot he was obliged to let it cool in the snow before he could handle it. They abounded in iron and nickel, and were analysed by *Vauquelin.*
1790. July 24. Fell the remarkable shower of stones at Barbotan, in the Llandes of Bordeaux. A large meteor was visible for 50 seconds, when it exploded with great noise and scintillations. The weather was very fine. When the stones fell, they had not their present hardness; some falling on bits of straw, the straw became incorporated with them. The fire-ball was of a pale but bright light, sufficient to dull the moon. The diameter of the meteor was larger than the moon. It proceeded from south to north with great velocity, and broke into portions of considerable size, flying in different directions like a bomb that bursts in the air. The light of these fragments went out as they fell on the ground, and they soon became hard. The explosion was like firing many pieces of ordnance, jarring the windows and throwing down utensils from their shelves. The fallen stones were found in a circular space two miles in diameter. The stones were much broken, and were of all sizes, 25 or 30 lbs. being the largest.
- Specimens of the Barbotan stone are not uncommon in the cabinets of the curious.—*Certified by the Mayor and Procurator of the Commune of Lagrange Juillac, in the Llandes of Bordeaux.*
1791. Stones fell in Tuscany.—*Soldani.*
1795. June. Twenty or more stones of a black, glossy surface, apparently recently vitrified, fell from a cloud in Sienna with an explosion resembling the discharge of cannon and musketry. Their fall was accompanied by a shower of sand, and the analysis showed that the sand and stones were identical in their composition, and were true meteorites.—*Phil. Trans.*, vol. 92.
1795. Stones fell in Ceylon.—*Beck.*
1795. A very remarkable fall of stones in the Wolds of Yorkshire. The largest weighed 56 lbs.—*Certified by Mayor Topham.*
1796. January. Stones fell in Beloga, Russia.—*Gilbert, Ann.*
1796. "Stones fell in the Meer of the Herdado, Portugal, with reports like the explosion of mines."—*Southey's Letters.*

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1798. Twelve stones fell at Sales, "one of which was the size of a calf's head."—*Marquis de Dree*.
1798. Stones fell in Bengal.—*Howard*.
1798. In the evening of March 12th a round or oval body, diffusing the most vivid light, moved westward over Ville Franche with a hissing, whizzing noise, like a bomb traversing the air. It exploded at a low elevation with a loud report. A large mass, irregularly oval, fell in a vineyard. Its weight was about 20 lbs. It was invested with a black varnished coating, and gave fire with steel.—*Jour. Phys. Sci. M. Dree*.
1798. A great fall from a luminous meteor or globe of fire took place at Benares, India. The natives gathered many fragments from the fields of various sizes, externally covered with a glossy black crust, and much broken by the explosion and fall. Internally they consisted of a great many spherical bodies imbedded in a light greyish, gritty, pliable substance, interspersed with metallic spicula. The spherical bodies were much harder than the surrounding stone. The outside attracted the magnet.—*Lord Valencia Howard*.
1799. April. Stones fell at Baton Rouge, Mississippi.—*Belfast Chronicle*.
1800. A vast luminous body passed over and was lost in the unknown wilds of America. "Perhaps," says Mr Howard, "its magnitude and solitary situation may become the astonishment of future philosophers."—*Phil. Mag.*
1801. In Isle au Tonneliers, stones fell from a globe of fire.—*Bory de St Vincent*.
1802. September. Stones fell from the sky in Scotland; and
1803. April 25th. A great fall of stones occurred at L'Aigle in Normandy. They were about 3000 in number. Fourcroy, Vauquelin, Biot, and others made the most thorough examination of them, and Vauquelin's analysis establishes their character as aerolites by the unfailing criterion of iron combined with nickel among their constituent parts. The sky was very clear when a globe of fire, of uncommon splendour, was seen moving toward the North, accompanied by reports resembling thunder, and double reports of cannon, with strange hissing and rattling like musketry; vapours were projected momentarily with the explosions, and innumerable stones were seen to fall. The largest weighed 17 lbs. and gradually hardened by exposure to the air. Fourcroy says, "They were exceedingly various in size and weight, covered

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with a black crust, and filled with small agglutinated grains of iron." When immersed in water they gave a sound "like the humming of a fly held by one wing." As they dry after being withdrawn from the water, they appear marked with curvilinear parallel layers.—*Biot's Letter in Journal des Debats.*

1803. Fragments of stones containing iron and nickel fell from a ball of fire, which struck the White Ball Inn at East Norton, England.—*Lit. Journal.*

1803. Stones fell in Avignon.—*Bibl. Britannica.*

1802. December. A stone fell near Eginfield in Bavaria.—*Imhof.*

1804. April. Three large stones fell near Glasgow.—*Van Beek.*

1804. An aerolite fell in October near Vaucluse.—*Analysed by Zagguire and Vauquelin.*

1805. March 25. Stones fell near the river Indoga in Siberia.—*Gilbert, Annalen.*

June 6. Stones covered with a black crust fell in a public square in Constantinople.—*Jour. of Mines.*

1806. Two aerolites fell at Alais.—*Analysed by Thenard and Vauquelin.*

1806. March. Two stones fell at St Etienne and Valance.—*Pierre Robout.*

1806. May. A stone fell near Basingstoke, Hampshire, England.—*Monthly Mag.*

1807. Stones fell at Smolensko 168 lbs. weight.—*Gilb. Annalen.*

1807. Dec. 14. A shower of stones fell from a brilliant meteor in Weston, Connecticut. The largest fragments found weighed 20, 25, and 35 lbs. Many fragments were much broken, but the estimated weight of the whole was 200 lbs.—*See Silliman's and Kingley's Memoir in Med. Rep.*

1808. Stones fell at Borgo, San Diolto.—*Guidottie.*

1808. Aerolites fell near Parma.—*Analysed by Guidottie.*

1808. Aerolites fell at Iglave, Moravia.—*Analysed by Vauquillier.*

1808. Aerolites fell at Lissa, Bohemia, with detonations like heavy ordnance. The sky was clear.—*Analysed by Klapproth.*

1809. In July a stone fell on an American vessel, N. L. 30° 58', 70° 25' W. Long.—*Bibl. Brit.*

1810. January. A stone fell near Hillsborough, N.C.—*Phil. Mag.*

1810. A great fall of stones at Shahadabad, India.—Vol. 37, p. 236, *Phil. Mag.*

1810. A stone fell from a small black cloud, with a whizzing noise, near Limerick.—*Analysed by Higgins.*

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1810. Nov. 23. Stones fell near Orleans, France, accompanied by reports like blowing up a powder magazine. One stone weighed 40 lbs., another 20 lbs., and one was lost. The day was very clear and bright.—*Analysed by Vauquelin.*
1811. A meteorite of 15 lbs. weight fell at Tcheringoff, Russia, with loud whizzing sounds and reports like thunder.—*Gilbert, Annalen.*
1811. July 8. Stones fell from the sky at Ballanquillas, Spain.—Tome 48, *Bib. Britain.*
1812. April. A shower of stones at Toulouse.—*De Auboisson.*
1812. Stones fell at Chantony, La Vendee, resembling the Barbotan stone, but containing more iron.—*Brocharest.*
1813. Large masses fell with a hissing noise and peals of thunder in Limerick. They broke in many pieces, the largest weighing 64 lbs.—*Attested by Samuel Maxwell, Esq*
1814. Stones fell in Calabria, and also in Bucharest, Russia.—*Gilbert, Annalen.*
1814. September. Large stones fell at Agen.—Vol. 14, *Phil. Mag.*
1814. November. In the Doab, East Indies, nineteen stones were found, weighing 30 and 40 lbs.—*Phil. Mag.*
1814. Sept. 5. A few moments before mid-day, and the sky serene, violent detonations were heard in the Department of Lot and Garonne; at first a rolling noise and sound of musketry, then the rumbling of carriages, and last of a falling house. There were a great number of stones found of all sizes, some weighing 20 and 30 lbs. Many were picked up by the peasants and worn as reliques.—*Annales de Chem.*
- 1815.. Oct. 3. A large stone fell at Langres.—*Pistollet.*
1816. A stone fell in Glastonbury, Somersetshire.—*Phil. Mag.*
1817. Stones fell in the Baltic after the great meteor at Gottenburg.—*Chladni.*

A few instances of Malleable Meteoric Iron will close this Catalogue.

The mass of malleable iron found by Pallas in Siberia was traditionally ascribed by the Tartars to a fall from the heavens. Its descent is lost in the remoteness of antiquity, but its appearance and its texture, little contaminated by impurities, lead to a belief in its meteoric origin. Its weight was somewhat more than 1658 lbs. and it was coated with the black varnished crust common to aerolites. The cavities in the mass were filled with a transparent amber-coloured substance in roundish drops. It was found lying on the top of a ridge, covered with fir trees, without adhering to the ground, or to any rock. No iron was near it; no

volcano within a thousand miles. It was first known to the learned of Europe in 1750.—*Voyages de Pallas*, tom. iv., p. 545; Paris, 1793.

A large mass of native iron was found in Bahia, Brazil. Its solid contents were estimated at 14,000 lbs. Its colour of a dark chestnut, and its surfaces coated with a glossy crust, indented, like the Sienna stone, and many other aerolites, as if struck with a hammer in its plastic, forming state, before it hardened. It was magnetic, and manifested well-defined polarity. Mr Mornay writes to Dr Wollaston—"From the presence of nickel in this mass, we cannot but regard it as of meteoric origin."—*Mornay to Dr Wollaston in Phil. Trans.* 1816.

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1818. A large mass, weighing 1635 lbs., discovered in Texas—now in the Cabinet of Yale College.—*Silliman's Chem.*

1792. Iron combined with nickel was found near Magdeburg; and an enormous mass, weighing 1900 myriogrammes, of iron and nickel fell near Agram in Hungary.—*Humboldt.*

1798. In Zacateccas in Mexico, a body of malleable iron and nickel was found analogous in its entire interior and exterior character to that Siberian mass described by Pallas.—*Humboldt.*

Meteoric iron fell at Elbogen, Bohemia. Also a large mass of iron at Lenarto, Hungary.—*Gilbert, Annalen*, vols. 42 and 44.

Native iron was seen by Captain Ross within the Arctic Circle at 76° N. L. Knives were made of it by the Esquimaux.

At the Smithsonian Institute in Washington is a fine specimen of meteoric iron from Mexico, weighing 252 lbs.

Since arranging the foregoing Catalogue I have been so fortunate as to see Shephard's interesting report to the "American Association for the Promotion of Science," which gives some additional accounts of meteoric iron, with a list of American Aerolites.

Meteoric Iron from Xiquipilco Toluca, Mexico, discovered in 1784.

Zacatecas,	discovered in	1792.
Cape of Good Hope,	"	1793.
Bitburg in the Eissel,	"	1805.
Resgalt, Columbia,	"	1810.
Elbogen, Bohemia,	"	1811.
Lenarto, Hungary,	"	1814.
Texas, Red River,	"	1814.
Lockport, New York,	"	1818.
Burlington,	"	1819.
Guilford, N.C.,	"	1820.
Randolph Co., N.C.,	"	1822.
Atacama, Bolivia,	"	1827.

Meteoric Iron from Bedford Co., Penn., discovered in 1828.		
Bohumilitz, Bohemia,	„	1829.
Scriba, N.Y.,	„	1830.
Claiborne, Alabama,	„	1838.
Cocke Co. & Sevier Co.,		
Tenn.	„	1839.
Walker Co., Alabama,	„	1839.
Ashville, N.C.,	„	1839.
Green Co., Tenn.,	„	1842.
St Augustine Bay, Ma-		
dagascar,	„	1843.
Arva, Hungary,	„	1843.
De Kalb Co., Tenn.,	„	1845
Otsego Co., N.Y.,	„	1845.
Hotmoney Creek, Bun-		
combe Co., N.C.,	„	1845.
Black Mountain, N.C.,	„	1845.
Tennessee (locality not		
ascertained).		
Scelasgen, Brandenburg,	„	1847.

List of American Aerolites from Shephard's Report on Meteorites to the American Association for the Promotion of Science.

From Weston, Conn.,	Fell in Dec. 14, 1807.	
Nobleboro, Maine,	„ Aug.	1823.
Nanjemoy, Md.,	„ Feb.	1825.
Sumner Co., Tennessee,	„ May	1827.
Richmond Va.,	„ June	1828.
Forsythe Ga.,	„ May	1829.
Little Piney, Pulaski		
Co., Mo.,	„ Feb.	1839.
Bishopsville, S. Carolina,	„ March	1843.
Linn Co., Iowa,	„ Feb.	1847.
Castine, Maine,	„ May	1848.

On the Effect produced on Trees and Shrubs by the Severe Frost experienced in December 1860 and January 1861.
By DUNCAN FORBES, Esq., Culloden.

The intense frost of Christmas 1860 proved, as is well known, very destructive to vegetation; many trees and shrubs were killed, and a still larger number were so severely injured that several years must elapse before the loss sustained can

be repaired. The great majority of those which have been killed or much injured, will in general be found to be such as are indigenous to countries where the temperature does not fall so low as it occasionally does in Britain. Many plants which were destroyed down to the ground, commenced on the return of spring to show signs of life, and as the season advanced put forth fresh and growing wood, which, in many cases, will result in their restoration to full health and vigour. To some extent, therefore, the loss will be only temporary, and not of so severe a nature as it was at first supposed to be.

The mean temperature of the summer and autumn of 1860 was, as ascertained by the Culloden Meteorological Register, more than $3^{\circ}0$ below the average, which, combined with the extreme wetness, had a most injurious effect on the growth of trees and shrubs,—the young wood having, in consequence, never ripened or hardened properly. Plants were thus less able to withstand the severe cold to which they were exposed, and to this cause must be ascribed, in part, the fact that many trees and shrubs which were considered hardy, from having withstood the severe winters of 1838, 1841 and 1855, perished under the severe frost of December 1860.

The districts embraced in this notice comprehend that portion of the Highlands which is included in the counties of Sutherland, Ross, Cromarty, Inverness, Nairn, Elgin, and part of Banffshire, and covering an area of nearly 300 square miles in extent.

A few facts we have gleaned relating to the effects of the severe frosts of 1838 and 1855 may not be out of place here. In February 1838, at Beaufort Castle, near Beaully, *Aucuba japonica*, *Laurustinus*, and Sweet Bays were killed. At Messrs Morrison and Son's nursery at Elgin, many plants till then thought hardy were killed. At Lossiemouth, the thermometer fell to $4^{\circ}0$, as shown from Dr Geddes's Register. At Belladrum, a low-lying situation, it is reported to have fallen to $-12^{\circ}2$.

At Culloden, during the frost of 1855, the thermometer at 4 feet from the ground fell to $11^{\circ}0$, whilst on the ground it indicated $1^{\circ}0$. The snow became so crisp and hard, that heavy objects in passing over it made no impression. On the

Nairn, the ice was so thick and firm, that horses and carts passed freely over it; and along the shores of the Moray Firth, there was an immense accumulation of ice, extending far out to seaward, and consisting of blocks of great size and thickness. Hares, rabbits, birds, and even some wild fowl, died from the intensity of the cold. The effect on vegetation, as might have been expected, was very destructive. In gardens, many kinds of shrubs, Laurustinus, Portugal and Bay Laurels of 20 feet in height, and Roses of various varieties, including China, Ayrshire, and other hardy sorts, were either killed or greatly injured. Forest trees also suffered,—the bark and stems of some kinds, such as the elm and the ash, being in many cases rent and split. In the grounds at Culoden, Laurustinus, Sweet Bays, Arbutus, *Rhododendron Russellianum*, several varieties of Roses, &c., suffered much. Some of the underwood of two promising Araucarias (the Chilian pine) were considerably injured, but all the specimens of the genus Pinus—*Cedrus Deodara*, *Picea nobilis*, *Abies cephalonica*—escaped untouched. At Dalvey, Morayshire, the temperature was repeatedly below zero; and hardy Laurels were very much injured, and Bays killed down to the snow-mark. At the Elgin Nurseries of Messrs Morrison and Son, a considerable number of shrubs were killed, viz., Arbutus, Sweet Bay, Cistus of sorts, various varieties of Cupressus, *Buddlea globosa*, and many others, much injured. At Gordon Castle, Banffshire, on the 22d February, there were instances of the stems of standard Portugal Laurels split to a considerable extent.

Frost of December 1860.—Previous to the 18th of the month the weather continued open and mild for the season; but on the forenoon of that day snow came on in thick showers from the north, so that by 10 o'clock at night the ground was covered to the depth of 4 inches. With this fall of snow, there was a great and sudden fall of temperature, the thermometer sinking to 18°·8 on the morning of the 19th, and never again rising (except once) to the freezing point, till the 29th. On the 24th the thermometer fell to 11°·2, and the mean temperature for the day was only 16°·7. So intense and continued

was the frost after the 18th, that ice from 8 to 12 inches in thickness, formed along the shores of the Moray Firth, and extended several hundred yards out to seaward.

I shall now add the several Reports I have received on the actions and effects of the frost, from the various districts embraced in this Report:—

Sutherlandshire.

1. Mr Mitchell, gardener, Dunrobin, writes,—“ The effects of last winter's frost here were not more injurious to vegetation than in any ordinary season. The lowest our thermometer registered being 15·5, the only things injured more than usual were *Laurustinus*, *Aucuba japonica*, and *Cryptomeria japonica*, the two former being killed in the ground, and the latter, a good plant, about 10 feet high, losing all its last year's growth. No doubt, our proximity to the sea had much to do with the milder temperature, our grounds not extending more than half a mile from the shore. I append a list of the injured and uninjured trees and shrubs:—

“ *Injured*.—*Laurustinus*, *Aucuba japonica*, *Cryptomeria japonica*.

“ *Uninjured*.—*Araucarias* (from 4 to 20 feet high), *Cedrus Deodara*, *Wellingtonia gigantea*, *Cupressus Lawsoniana* (and varieties), *Buddlea globosa*, *Escallonia rubra*, *Escallonia macrantha*, *Gynarium argenteum*, Sweet Bay, Common Laurel, Portugal Laurel, Roses, Apricots, Peaches, and other fruit trees.”

Ross-shire.

2. Mr Hannay, gardener at Invergordon Castle, writes: “ We have lost very few plants from the effects of the frost of last winter,—the *Wellingtonia gigantea*, of which we have two, the one the finest in the north, 7 feet high, and five years planted, stood out well; they appear quite hardy. The *Deodaras* had the points of the previous year's shoots killed. *Aucubas* and *Larustinus* killed to the ground. The thermometer was never below zero.”

3. Mr Andrew Smith, of Dingwall, reports generally on the effects of the frosts in various parts of Ross and Cromarty,

including the well-known gardens of Conon, Castleleod, Tulloch, and Ardross.

“*Killed*.—*Cupressus torulosa*.

“*Injured*.—*Cryptomeria japonica*, *Araucaria imbricata*, *Abies Kämpferi*, *Pinus Sabiniana*, *P. Craigana*, *Thuja aurea*, *T. Lobbianae*, *Berberis Darwinii*, *Cupressus Macnabiana*, *Cedrus Deodara*.

“*Uninjured*.—*Wellingtonia gigantea*, *Cupressus Lawsoniana*, *C. Lambertiana*, *Abies Douglasii*, *Berberis japonica*, *Pinus Jeffreyi*, *P. Monticola*, *Cephalotaxus Fortunei*.

“I have observed some instances of perpendicular rents, from 3 to 8 feet in length, in Turkey oaks. I have heard of a good many deaths among grown-up trees, but cannot specify as to numbers or species killed. I may mention that I have observed that *Araucarias* and *Deodars* have suffered less in high and exposed situations than when growing in low over-sheltered places.”

4. Mr Christie, gardener, Conon, reports the loss of a few plants of interest :—

“*Killed*.—*Cupressus Macnabiana*, *C. torulosa*, *Cedrus Deodara* (two years seedlings killed, older plants suffered in foliage only), *Picea nobilis* (seedlings), *Araucarias* (seedlings), *Arbutus*, Chinese Privets.

“*Injured*.—Common Laurels lost their branches in a few instances; and all fruit trees suffered more or less—neither Apple nor Pear trees bearing any fruit on them.

“*Uninjured*.—*Cupressus Lawsoniana*, *Thuja borealis*, *T. gigantea*, *Wellingtonia gigantea*, Portugal Laurel, *Abies Douglasii* (a bed of 100 seedlings all untouched), an older *Araucaria*, the finest in the north, if not the largest specimen in Scotland, quite safe.”

5. Mr Stewart, gardener, at Brahan Castle, supplies the following information as to the action of the frost :—

“*Killed*.—*Cephalotaxus Fortunei* (male killed, female much injured), *Cupressus torulosa* (out of twenty-four plants, 18 inches high, only six remain alive), *Pinus excelsa* (some killed and the others very much injured), *Biota orientalis aurea* (one plant killed, the others very much injured), *Arbutus Unedo*.

“*Injured*.—*Picea Webbiana* (severely), *Cedrus Deodara* (slightly), *Cryptomeria japonica*, *Sequoia sempervirens* (young wood of previous year killed), *Taxus adpressa*, and *Cupressus Goveniana* (severely).

"The only kind of timber I see injured in this quarter is the Turkey Oak. I see rents on this kind of Oak from 2 to 8 feet long, in nearly all trees which have attained to the age of thirty or forty years. No other kinds of growing timber show any appearance of injury. The Whin has been killed in several places in the neighbourhood. The Rhododendrons and Azaleas grow in millions in the shrubberies from self-sown seed. The seedling Azaleas have been partially destroyed by the frost; but the Rhododendrons do not appear to have sustained any injury. Out of 120 varieties of Rhododendron, *Falconeri* and *Victoria Regina* have suffered more than any others."

6. Mr Fraser, gardener at Redcastle, reports—"That the severest frost experienced at Redcastle last winter was on the night of the 24th December, when the thermometer fell to $-3^{\circ}0$. The injury, however, to tender plants was not very great.

"Some fine specimens of *Picea Webbiana*, from 8 to 10 feet high, had the previous year's wood killed, and to all appearance will never recover. *Cedrus Deodara*, young plants much injured; *Pinus Sabiniana*, killed; *Araucaria imbricata*, untouched. This is a particularly fine specimen, height 21 feet, branches cover 14 feet; girth, at one foot from the ground, 2 feet 3 inches; and at 6 feet high, 1 foot 9 inches; was planted as a seedling in 1843, and has made rapid growth each year; *Cupressus torulosa*, a strong plant, killed."

Inverness-shire.

7. Mr Muir, gardener at Beaufort, informs me that the injury done there has not been very great. "*Abies Douglasii*, except on low, damp, exposed grounds, where the young unripened wood has been killed. *Araucaria imbricata*, where exposed in the parks, slight injury done to the points; but the principal specimens in the shrubbery untouched. *Taxodium sempervirens*, young wood killed; Common Laurel slightly injured; Rhododendron safe, except in one part of the shrubbery, low and damp, where they are slightly injured. A few Hybrid Perpetual Roses, on 4 feet stocks, killed; a few

root grafted also killed ; Bourbon and China Roses likewise killed. The Whin in exposed situations has been killed."

8. Mr Findlay, gardener at Relig, writes, "That the frost of December and January did little or no injury. One large Apricot tree and a few Hybrid Bourbon Roses only killed. None of our coniferous trees have suffered in the slightest degree. The grounds at Relig contain particularly fine specimens of *Abies Douglasii*, *Cedrus Deodara*, and *Pinus Cembra*. In 1858, the sizes of each of these were taken. The height of *A. Douglasii* was then 31 feet 8 inches, girth near the ground 2 feet 3 inches. *Cedrus Deodara*, height 25 feet 8 inches, girth of trunk 4 feet. *Pinus Cembra* was 30 feet 8 inches in height, girth at the ground 6 feet. There are likewise here several Cedars of Lebanon in great beauty. A severe frost in the spring of 1846 slightly injured the foliage and tender wood, but since then they have continued healthy, and during the past winter have, in common with the Pines, remained uninjured."

9. Messrs Howden, Brothers, of the Muirtown Nurseries at Inverness, report, "That the frost has done very little damage here, as compared with the nurseries further south. Near Edinburgh, the hardiest shrubs, such as Common and Irish Yews, Common and Variegated Hollies, and *Rhododendron ponticum* have suffered, while here the same shrubs escaped injury. As regards Forest Trees, they have sustained no injury ; and the same remark applies to Ornamental and Fruit Trees, except Peaches upon walls, which have had the points of the shoots destroyed, and some trained on boards are more seriously injured—a few even killed. The state of the Shrubs and Conifers affords the best criterion of the last winter ; but, as we had a heavy covering of snow sheltering the main part of our stock, we will only report on such plants as, being above the snow, were exposed to the severity of the frost :—

" *Killed*.—*Arbutus Unedo* and *Aucuba japonica* (killed above snow), *Cryptomeria japonica* (young plants killed, older plants injured), *Cupressus sempervirens*, *C. torulosa*, *C. Lambertiana*, *C. funebris*, *Eleagnus reflexa*, *Euonymus japonicus*, German cistus, *Jasminum revolutum* and Common White, Jasmine, Juniperus

Bedfordiana, *J. recurva*, *J. lycia*, *Laurus nobilis*, Lavender, *Laurustinus*, Rosemary, *Taxodium sempervirens*, Irish Whin.

"*Injured*.—*Araucaria imbricata* (much), *Cedrus Deodara* (young shoots), Portugal Laurel (slightly), Phillyreas (much), Irish Whin, double flowering (much)."

The plants above stated to be killed are alive where covered with snow ; and it is hoped that those may recover which are only injured. Roses—Climbing Evergreen, Bourbon, Noisette, hybrid and tender varieties, killed to snow covering.

"*Uninjured*.—The following plants among others have escaped injury, though exposed to the full effects of the frost :—*Cupressus Lawsoniana*, *Wellingtonia gigantea*, *Garrya elliptica*, *Thujopsis borealis*, *T. aurea*, *Juniperus excelsa*, *Pinus Douglasii*."

10. Mr Findlay, gardener, Aldourie, says, "That having only a small collection of tender shrubs at Aldourie, the memorable frost of last winter did not do so much damage. Besides, the fact of being situated on the banks of Loch Ness, the water of which has never been known to freeze, may have had the effect of lessening the severity of the frost.

"*Escallonia rubra* killed to the surface of the snow.

"The following have been injured—Common Laurel, Portugal Laurel, Sweet Bay, *Laurustinus*, many Standard Roses, *Cedrus Deodara*, *C. Libani*, *C. atlantica*. The injury is in general slight, but in some instances last year's shoots have been destroyed."

11. Mr Barnet, gardener at Culloden, has furnished me with the following note for December 1860 and January 1861 :—

"The frost, though very severe during the period over which it extended, has not injured, to any great extent, any of the Pines or tender shrubs.

"*Killed*.—*Laurustinus*, *Laurus nobilis*, *Escallonia*, Phillyrea, *Aucuba japonica*.

"*Injured*.—Irish Whin (yellow), and Portugal Laurel (slightly), Roses, many varieties, and Myrtles in exposed situations (more or less).

"*Uninjured*.—*Araucaria imbricata*, *Pinus nobilis*, *P. cephalonica*, *Cedrus Deodara*, Irish Yew, Common Yew, Common

Laurel, Common and Variegated Hollies, Rhododendrons, Evergreen Oaks."

Moray or Elginshire.

12. Mr Mair, gardener, Darnaway Castle, considers the damage done by last winter's frost to have been greater among Fruit Trees and Roses generally than was the case in 1855; that the various kinds of shrubs suffered to a greater extent during the frost of that period, when all the common varieties were cut down to the ground.

"*Wellingtonia gigantea*, *Abies Douglasii*, and *Pinus Jeffreyi*, were all uninjured. I have not heard of any trees being damaged by the action of the frost in any part of the Darnaway forests during the past winter."

13. Mr Berry, gardener at Dalvey, writes, "That the collection of Pines and other half-hardy plants is not a very extensive one; consequently we have not had many losses arising from the severity of the winter.

"The thermometer fell no lower last winter than 3°·0, whereas in 1855, for four nights in succession, it fell to -5°·0. But, owing to the unripened state of the wood, Roses suffered more severely last winter than during the previous fourteen winters.

"*Killed*.—*Cupressus funebris*, *C. torulosa*, *Pinus longifolia*, *Abies Brunoniana*.

"*Injured*.—*Taxodium sempervirens*, *Berberis Darwinii*.

"*Uninjured*.—*Cedrus Deodara*, *Cryptomeria japonica*, *Thuja Craigana*, *Araucaria imbricata*, *Wellingtonia gigantea*, Laurels, Hollies, Yews, and hardy Evergreens.

"The thermometer fell to 22°·0 on the 18th of December, and ranged during the four following nights between 8°·0 and 14°·0, and on the night of the 23d it fell to 3°·0."

14. In the nurseries of Messrs Morrison and Son, at Elgin, the loss among pines, shrubs, &c., has been considerable, though not to so great an extent as, judging from other causes, might have been expected. Mr Harrison says—"From whatever cause, our loss was less severe than what was generally experienced farther south. Our common Laurels are but little

injured; last year (1859) we had great numbers of them cut down to the ground. Many other shrubs have also escaped this year. Amongst our Pines, *Wellingtonia gigantea* appears quite hardy, as well as all the species from Upper California, and from our new colony on the Fraser River. Those introduced, however, from Lower California, are more or less injured, such as *Pinus insignis*, *P. radiata*, and the allied class of Pines. They appear to have much sap in them in summer and autumn, and I believe it never ripens; and when severe frost sets in, the tissue is destroyed. When covered with snow, they remain uninjured; and I consider it not unlikely, that if grown in poor light soil along the sea-coast, they would stand. Most of the newly-introduced shrubs are turning out hardy. I am, however, sorry to see *Escalonia macrantha* a good deal injured when not covered with snow. The covering of snow furnished a valuable protection, the greatest damage sustained having taken place after the slight thaw that occurred in the early part of January. The lowest temperatures which were observed here were 7°·0 and 9°·0 at two different stations. On the 24th December, at Altyre, near Forres, the thermometer was observed so low as -4°·0, and there, in two cases, trees were split by the frost. This has been confined to hard wood, ash being apparently more liable to splitting than elm or oak. Since it occurred in old trees, it was supposed at first that there had been some internal decay, into which water had found its way, and thus caused the splitting; but nothing was found on examination leading to such a conclusion. Hence the splitting was probably due to the freezing of the sap. *Araucaria imbricata* has been very much browned, but one plant growing in a very exposed situation has stood quite uninjured. It has been killed to a great extent in the Aberdeen nurseries. In most gardens in this district, Peaches have been injured, especially young trees, but I have not heard of any of the older ones being actually killed. No seedling forest trees have been injured here, except one plot of one-year seedling Thorns, which were very strongly grown, and the tops of which had not been well ripened. The same thing occurred in regard to some Planes or Sycamores, and a few seedling Oaks, which

had made a second growth. The only transplanted trees I observe injured are some Spanish Chestnuts. All our Roses have been considerably injured.

List of Plants which have been either killed or injured.

"*Seedling Forest Trees.*—Common Thorn, Plane or Sycamore, and English Oak—slightly injured.

"*Transplanted Forest Trees.*—Spanish Chestnut—slightly injured.

"*Plants suitable for Underwood.*—*Bignonia radicans*—killed. *Vinca major elegantissima* and *Wistaria sinensis*—slightly injured.

"*Standard Ornamental Trees.*—*Quercus Cerris*, *Q. Lucombeana*, and *Q. Cerris Exoniensis*—slightly injured.

"*Hardy Deciduous Flowering Shrubs.*—*Amygdalus persica alba*, *rubra*, and *incana*—killed. *Azalea japonica*, *Cotoneaster acuminata*, and *Hydrangea arborescens*—slightly injured.

"*American Plants and Evergreen Shrubs.*—*Abelia uniflora*, *Laurus regalis*, and *Mitraria coccinea*—killed. *Arbutus Unedo*, *Aucuba japonica*, *Escallonia macrantha*, *E. organensis*, *E. Pterocladon*, *Garrya elliptica*, and Common Holly—slightly injured. *Ceanothus azureus*, *C. dentatus*, *Cistus formosus*, *C. lusitanicus*, *Eugenia*, *Laurus nobilis*, *Ligustrum lucidum*, *L. japonicum*, *Phillyrea angustifolia*, *P. ilicifolia*, *Rhamnus alaternus*, *Veronica Andersoni*, *Viburnum Tinus*—much injured.

"*Hardy Coniferous Plants.*—*Araucaria imbricata*, *Cedrus atlantica*, *C. Deodara*, *Cupressus funebris*, *Pinus maritima*, *Taxodium sempervirens*—slightly injured. *Abies Brunoniana*, *Cryptomeria japonica*, *Cupressus Lambertiana*, *C. torulosa*, *Pinus insignis*, *P. muricata*, *P. radiata*, *P. tuberculata*—much injured.

"Young Nectarines and Peaches in some instances were killed."

Banffshire.

15. Mr Webster, gardener at Gordon Castle, supplies the following information:—"The injury done here by the frost in December and January has been comparatively little. Roses, which have suffered generally throughout the country, have sustained considerable injury. Ayrshire Climbing, with a few exceptions, have been killed. Hybrids, Perpetuals, and Bourbons have also suffered. I find it difficult to say which are really hardy, as I find them dead in one situation, and alive in another. Of shrubs, the following have been injured:

—Laurustinus, Evergreen oak (young only), Phillyreas, Arbutus (young).

"A plant of *Magnolia grandiflora*, covering a wall 12 feet high by 15 wide, lost nearly all its leaves, and some of its young wood; another of *Magnolia*, larger in size, uninjured, except in its flower buds.

"*Clematis azurea grandiflora*, killed to the ground.

"We are not in possession of extensive collections of Pines, but those we have have proved hardy, and are uninjured—*Cedrus Deodara*, *Wellingtonia gigantea*, *Araucaria imbricata*, *Cryptomerias*, *Cupressus*, Common Laurel, and Portugal Laurel.

"I have not observed any of the largest forest trees injured in any way. Whins in the surrounding districts have suffered, particularly those in exposed situations and in hedgerows.

"The lowest temperature, $10^{\circ}0$, was observed on the morning of the 26th December. The lowest within the last ten years was on the 22d February 1855; the thermometer then indicated $4^{\circ}0$; the injury to roses and other plants, however, at that time, was comparatively little."

Observations on Atmospheric Temperature, by Dr WILLIAM BALFOUR BAIKIE; made on the West Side of Tropical Africa. Communicated by Sir JOHN RICHARDSON.

According to observations which I have made pretty regularly since 1857 in Mipe, and at the confluence of the Kwora and Binuwè, the coldest period during the twenty-four hours is from fifteen minutes to an hour after sunrise.

With a very few exceptions, the thermometer always falls just after sunrise, from $0^{\circ}2$ to 2° . If the thermometer be read about fifteen or twenty minutes before sunrise, and then at sunrise, it will be found to have risen from $0^{\circ}5$ to 1° , but fifteen or twenty minutes later it will be found to have fallen again. For example, this morning at 5^h 45^m A.M. the thermometer was 75° ; at sunrise it was 76° , and at 6^h 30^m it was again 75° .

Another constant rule is, that the lower the thermometer the more certain is this fall after sunrise, and the greater its extent. In December and January the mornings are very cold, the thermometer sometimes showing 60° , and even 58° , and it is then that the fall after sunrise is most marked. During the rain-season the temperature is more equable, less in extremes, and then this fall is much less, sometimes scarcely perceptible. As far as I have observed, the fall is greater after sunrise the farther north we go, and is more marked on high than on low lands. In December and January I have seen the thermometer range more than 40° daily. From June to October the range seldom exceeds 15° or 16° daily.

During 1860 and 1861, the temperature of Tornado rain, whether by night or by day, was rarely below 70° or above 72° . Tornadoes are from N.E. to S.E. Rain coming from the S.W. is generally rather warmer.

On the Danger of Hasty Generalization in Geology. By
ALEXANDER BRYSON, Esq., F.R.S.E., President of the
Royal Physical Society of Edinburgh.*

It is proper, before alluding to the failings of our friends in making hasty generalizations, to confess our own failures, so that by plucking out the beams from our own we more readily detect the motes in our neighbours' eyes. The first instance which I shall notice of erroneous conclusions, drawn from scanty data, occurred to myself in 1856. Our late lamented fellow, Dr Fleming, brought me one day a very beautiful specimen of Carrara marble, on which was exhibited the most decided marks of a fossil plant, and, being much engaged at that time in the microscopic study of the Carboniferous flora, I felt no hesitation in pronouncing it to be a true *Stigmaria*. This being a new fact in geology, of course the specimen was often exhibited to demonstrate the existence of carboniferous fossils in the primitive limestone. Fortunately for truth, a friend obtained many similar specimens in the establishment of a marble-cutter in Leith Walk, where I

* Read before the Royal Society of Edinburgh, April 21, 1862.

soon found the true explanation of the structure which had led me to maintain its organic origin.

It is usual for the marble-cutters at Carrara, before sending out the blocks from the quarry, to reduce them into as small dimensions as possible. This operation is performed by what is called a matting-hammer, consisting of many separate and blunt teeth placed alternate to each other, and is used by bringing the hammer down, in a perpendicular direction, to the flat face of the marble block. By this method a series of quinquencial indentations are produced precisely similar to those found in *Stigmaria*, and, to render the illusion more perfect, where the percussion of the teeth of the hammer is greatest (which is at the point), the limestone at the bottom of each depression is more crushed, and being deprived of its air by the greater force, exhibits a different structure from the surrounding walls, and thus presents the regularity, both in shape and direction, of the protruding petioles of *Stigmaria*.

Unfortunately, before this discovery was made, my dear friend Professor Fleming died, and I have no doubt that this specimen is now lying in his cabinet, labelled on my authority as a *Stigmaria*,—no stigma on his naming, but on mine.

In the summer of 1856 a few friends joined me in a yacht-ing expedition to examine geologically the islands of the Firth of Forth. Among other islands we visited Inch Mickery, and spent some hours examining its structure. On the southern summit of the rock we found a quantity of lead filling up many of the interstices of the trap, which besides had a very scorched appearance. This circumstance naturally excited our curiosity, and many theories were formed to unriddle the enigma, but in vain. We carefully examined the island, but could not find a trace of fire by which the lead could have been melted, except at such a distance from the spot as to render the idea of lead being carried so far without cooling inadmissible. Then the lead had run into the crevices of the rock, showing that it must have been very fluid when it fell.

The absence of every trace of carbon around the lead, or at all near the rock itself, was very puzzling. About this time Dr Heddle had announced the occurrence of native lead embedded in meteoric iron, and I at once held my Inch Mickery

lead as truly meteoric in its origin. This idea was rendered the more probable, as the late Dr George Wilson, who kindly analysed it for me, failed to detect in it any trace of silver. Professor Fleming, although he scouted the idea of its meteoric origin, was induced to accompany us on a second visit to the island. After a personal examination, he was unable to throw any light on the subject, but advised us to wait patiently, and time might clear up the mystery. We would have rejoiced had he lived to learn the simple explanation, only obtained a few months after his lamented death.

The Board of Fisheries, some years since, perhaps believing that garvies were young herrings, passed a law forbidding nets to be used the meshes of which were smaller than those employed in taking full-grown herrings. The officers of the Board happened to detect a boat using the illicit nets just off Inch Mickery; they, acting according to orders, took the offending nets to this rocky knoll and burned them. The leaden sinkers attached to the nets supplied my meteoric lead, and the cordage of the net yielded sufficient fuel to fuse it. The winds and rain soon took away all traces of the cause by which the lead was fused, and thus led to our confusion,—and so our hypothesis went to the winds.

I have now to deal with another instance in which a hasty generalization has met with more attention in the geological world than any of those I have mentioned, but not less than it deserved. Mr Geikie, in a paper published in the "*Edinburgh Philosophical Journal*," vol. xvi. p. 102, has stated his belief that the ground on which Leith is situated has risen to the extent of 25 feet since the Roman period. The section from which he has come to this conclusion is in a sand-pit at the Junction Road, Leith, and is represented in the diagram, which is the same as Mr Geikie used to illustrate his paper. He thus describes the succession of the strata as seen in the sand-pit:—

"The lowest bed (1) visible is one of coarse gravel or shingle, the pebbles being all well rounded, and loosely cemented in a sandy and somewhat ferruginous matrix. (2) Is a bed of fine white sand, about six feet thick. It is full of false bedding, the diagonal stratification being beautifully exhibited by the alternations of darker and lighter coloured

layers. Its upper surface is irregular, and is overlaid by a well-marked seam (3) of sand and gravel, which averages about sixteen inches in thickness. Its lower part is gravelly and ferruginous. This stratum is covered by three or four inches of a stiff greenish clay (4), which contains numerous perpendicular (sometimes dichotomous) ferruginous pipes, probably marking the remains of the stems of plants. This stratum passes up into a bed (5), about six feet thick, of dark silt or sandy clay well stratified, having thin lenticular inter-



Section of Sand-pit, Junction Road, Leith.

laminations of sand, with occasional oyster-valves, a few stones, and fragments of bones and pottery. The upper part of this bed becomes more sandy, and graduates into the superincumbent stratum of brown sand (6). The highest bed of the section (7) consists of stratified sand and shingle full of littoral shells, and some of the stones having *balani* still attached. The irregular deposit (marked *h* in the diagram), which rests unconformably upon the edges of the strata just described, is a mass of loose humus, which has been thrown down here at no distant date, perhaps to fill up an irregularity of the surface. It is full of stones, bricks, bones, pieces of earthenware, tobacco-pipes, &c., and its origin is sufficiently explained by a large board a few yards distant—'Rubbish may be laid down here free.'

"It is with the stratum marked 5, that we have chiefly to deal. But before entering into its details, I would dwell pointedly on the fact, that it is a regularly stratified deposit,

with thin parallel interlaminations of sand and clay; its oyster-valves and stones lie horizontally, and it passes upward by gradations into brown sand, which is covered by well stratified shell-sand and gravel. It cannot for a moment be confounded with the dark earth *h*, in which no trace of stratification can be detected, and which, moreover, rests on the edges of the other deposits. Whatever may be the contents of this bed of silt, they are undoubtedly of contemporaneous deposition; in other words, all the materials imbedded in the stratum were laid down at the same time with the stratum itself. And that this deposition and arrangement were effected tranquilly by the tides, is abundantly manifest from the stratified aspect of the bed, as well as from that of the sand which covers it." In this bed (5) Mr Geikie found pieces of pottery and bones, to which he thus alludes:—"The pieces of pottery found by Dr Young and myself were of two kinds; the first and most abundant were of a pale yellowish-grey colour, from two to nearly six lines in thickness, and of a firm compact, but somewhat granular clay. They showed no glaze, but had a rough exterior and a rounded form like fragments of a flagon or urn. All the pieces we obtained occurred in the space of two or three yards, and might have belonged to one vessel. We also found, however, one or two fragments of a thinner and finer kind of pottery of a red colour, and coated with a pellicle of greenish glaze. Having obtained as many fragments as could be gathered, after a careful search during two visits to the sand-pit, we submitted them to Mr M'Culloch, the curator of the Scottish Antiquarian Museum, requesting his opinion before informing him where they had been found. He at once pointed out, that they strongly resembled fragments of Roman pottery; and he stated, that if found near a Roman station, he would have no hesitation in pronouncing them to be Roman." "We have no doubt, therefore, that the pieces of pottery embedded in the elevated littoral silt of Leith are of Roman origin."

"Along with these remains occurred numerous fragments of the bones of some ruminant, apparently a deer. With the exception of a broken tibia, all the pieces were of small size, like little chips and splinters. There occurred also a number

of ferruginous pipes of irregular size and form, occasionally branching. They arose probably from the decomposition of ferruginous soil round the decaying stems of plants, though they sometimes resemble annelide burrows.

“ I have just shown that the bed of silt in which these remains occur, is a truly stratified deposit formed by water, exactly as a similar silt is being laid down on the shores of the Frith at the present day. The occurrence of stratified shell-sand and shingle above this silt proves that it was a littoral deposit; and the inference is irresistible, that the land here has risen about 25 feet since the deposition of these littoral strata. Further, the existence of fragments of Roman pottery in the silt shows us, that the deposition of these up-raised strata was going on during the Roman occupation of Britain, and therefore that this rise of the land has taken place since the time of the Romans. This may seem, indeed, a startling deduction, when we consider the comparatively large increase of land which it demands, the short interval it allows for the process of elevation, and the silence of historians as to any change of level. But these objections are only negative, and cannot be entertained in the face of the clear, positive evidence of the raised sea-beach itself.”

When this communication of Mr Geikie's appeared, Dr M'Bain (who had previously studied the relation of the beds) and I determined to make a careful investigation of the sand-pit, more particularly bed No. 5 of Mr Geikie's section. We were aided in our researches by the kindness of Mr Field, the proprietor of the sand-pit, who placed his men at our service for the purpose of excavating the stratum. The result of many visits confirmed our belief, that there was no proof of any rise of the shore at Leith within the human period, for the following reasons, which I shall briefly state.

First, as to bed No. 5, in which the so-called Roman pottery was found, on which Mr Geikie lays so much stress, and is indeed the *point d'appui* of his whole argument. Instead of finding this bed to be of marine origin and distinctly stratified, as Mr Geikie has described it, we found it (as any one can determine the fact for themselves) to consist of two distinct beds, the lower one, which rests on gravel, is evidently a

marsh silt due to the overflowing of the Water of Leith, the remains of which may still be seen about 100 yards to the west. That this marsh existed not in the Roman age, but within the memory of the oldest inhabitant, is rendered highly probable, by the situation bearing the name of Puddock Hall, evidently from its proximity to the abode of frogs. That this marsh silt was deposited long posterior to the Roman occupation, we shall endeavour in the sequel to prove. The silt stratum or lower portion of bed (5) contains no remains of animals nor pieces of pottery; when dessicated by exposure to the air, it separates into prisms perpendicular to the clay-bed below, and is thus easily differentiated from the upper stratum in which Mr Geikie found the so-called Roman pottery.

The upper portion of No. 5 is distinguished from its lower congener by numerous vesicular coal cinders, evidently acted on by heat, and as the matrix shows no symptoms of fusion from internal heat or otherwise, I take leave to denominate as simply coal ashes. Side by side with the incinerated coals we found oyster shells, not *all* lying flat, as deposited in a bed, but at *all* angles to the horizon, precisely as any one may find them in a humus bed, where a farmer, knowing their worth for manure, had shut them in at random. Nor were the stones, as Mr Geikie has said, lying on their sides (as would have been the case if this bed had been a lacustrine or marine deposit) but were arranged in as higgledly-piggledly a manner as the oyster shells. We, with the assistance of Mr Field's men, had no difficulty in supplying ourselves with from thirty to forty specimens of pottery, also bones of sheep, the common ox (*Bos taurus*), teeth of the same, and also of the horse. Only one evidence of the deer was found, and that was a tooth. Before entering into the further proof of this bed being of *very* modern origin, let us consider first the occurrence of the burned coal so largely sprinkled through its mass, and ask ourselves or Mr Geikie the question, was coal so commonly consumed at the period of the Roman invasion, so as to yield so large a percentage of the bed? For myself I answer in the negative. With regard to the horizontality of the oysters and stones, I leave those who feel interested in the controversy to convince themselves; but I cannot help expressing my own

opinion that the number of oyster shells in the upper part of bed (5) are not greater than can be found in any humus bed supplied by the manure of the city of Edinburgh; nor are they evidence of marine deposition more than can be afforded by any well-cultivated field of Mid-Lothian. I shall now advert to the character of the pottery found in bed (5), where Mr Geikie found his Roman pottery. Above I have stated that we found upwards of thirty specimens of the fictile art; these were submitted to the inspection of Mr Birch of the British Museum, the first authority we have in the kingdom as regards pottery. His answer was, "not one piece is of Roman origin."

Another gentleman, second only to Mr Birch in his knowledge of pottery, pronounced them to be of local and modern origin; in this opinion he was both right and wrong. In regard to the pottery being of local origin, I found that the red pottery owed its formation to a manufactory at Portobello, where elegant jugs after the Etruscan mould were made to hold butter-milk, and the others were remains of neat glazed flower-pots from Holland, which forty years ago the skippers brought over to adorn the parlours of their wives.

During our diggings in this bed No. 5, we frequently met with the stems of tobacco pipes, which, of course, did not by any means prove its Roman deposition; pursuing our researches further, we found five heads or bowls of pipes bearing the initials T. W. Knowing only one tobacco-pipe manufacturer in Edinburgh, we submitted them to him, and asked when they were manufactured. His reply was, "these are the initials of my father-in-law, to whose business I succeeded, and could not have been made before the year 1814, when he founded our establishment."

But another proof of this bed No. 5 being a humus bed, exists in the testimony of an old man, Thomas Anderson, who forty years ago cultivated this identical bed before beds Nos. 6 and 7 were laid down.

The question now arises, how were the beds 6 and 7 laid down? Bed (6) was the "tail end" of Mount Falcon, raised by Oliver Cromwell, and levelled over bed 5, when the road was made for the proposed advent of George IV. into Edinburgh in 1822. Bed No. 7, Mr Geikie describes as consisting of a true beach

bed with all its shells and balani, and he is led to believe that the deposit was truly laid down by the sea. There are, however, two facts which at once set this aside; 1. The balani are often found on the stones with their valves *downwards*, instead of exposed to their native element; and, 2, bed No. 7 was taken out within eight years from the foundation of a house, and entirely consists of the same shells, &c., which form bed No. 1 of Mr Geikie's section, to which I shall now devote a few words, showing that it was formed within the historic epoch, and long after the advent of the Romans. From the Ordnance Survey map I have taken various contour levels of the streets and quays of Leith to the number of seventy-two. These give an average height above mean high water of 28·7 feet. Now, as the tides vary from neaps to springs about 16 feet, we must deduct from this half the amount, equal to 8 feet; this leaves for average tides a height of 20·7. Now, as the oyster bed of Mr Geikie, or rather his No. 1 (which I call a storm-raised bed) is 1·5 feet below the average of the streets of Leith, we have only to account for a storm-wave five feet in height, to throw up their so-called raised sea-beach bed so much insisted on by Maclaren and Chambers.

Such condition of the tides have often been observed by the elder inhabitants of Leith, the effects of which could not of course affect land lying below the houses. But let us suppose the condition of Leith before or immediately after the Romans laid the "Fishwife's Causey," and man had not placed barriers against the sea, but that the piers, harbours, and houses of Leith, with all their defences, were removed, old Ocean would soon re-assert his former sway, and claim as his domain the links of Leith, and leave at all high tides, and during N.E. storms, effects equivalent to those which make this storm-raised bed the stumbling-block of all geologists who attempt to prove that we have any very *modern* evidence of a subsidence of the sea or a raising of the land.*

* Since the above was written, the bed No. 7 of Mr Geikie's section has been nearly all removed, the only portion remaining may be carried away in six or eight cart loads. The section exhibits now, what it did before, that humus and sand were alternate, as the carts which carried the stuff of the foundation were loaded anon with earth and then with sand.

Remarks on the so-called Raised Sea-Beach Bed in the Neighbourhood of Leith, and its Relations to other Deposits. By JAMES M'BAIN, M.D., R.N.*

The superficial deposits which repose upon the grooved and dressed surface of the solid rocks have been classified under various appellations, according to the opinions entertained from time to time as to their mode of origin. In the "*Reliquiæ Diluvianæ*," published in 1823, the superficial strata are ascribed to a recent and transient inundation, considered to be identical with the Noachian Deluge; hence the terms diluvial, ante-diluvial, and post-diluvial, adopted in that celebrated work. These names ceased to be employed in this sense by geologists after the well-known reply of Dr Fleming, entitled "*The Geological Deluge, as interpreted by Baron Cuvier and Professor Buckland, inconsistent with the Testimony of Moses and the Phenomena of Nature.*" A general description of the superficial accumulations has been given by Mr Milne-Home in a valuable memoir "*On the Lothian Coal-Fields.*" This author states, that it is possible to identify and individualise at least seven formations, each having separate characters, and probably belonging to different epochs. Under the existing soil supporting vegetation, there is, *1st*, An upper covering of gravel and boulders; *2d*, A deposit of sand and shells; *3d*, Beds of fine sand; *4th*, Beds of fine clay; *5th*, Coarse gravel or stony clay; *6th*, Lowest boulder-clay; *7th*, Beds of sand and gravel. In the "*Lithology of Edinburgh*," Dr Fleming divides the strata belonging to the modern epoch into three groups,—*1st*, The Taragmite series, formed subsequently to the dressings and groovings of the solid rocks, and, where present, reposing on them. They seem to have been formed when violent aqueous movements were taking place, and probably at a period when the state of our island was widely different from the present. The second, or Akumite series, is chiefly characterised by its laminated clays and sands, and indicates the assorting power of water under circumstances of comparative tranquillity. The Phanerite group consists

* Read to the Royal Physical Society, May 7, 1862.

of deposits produced by causes in ordinary operation, and respecting the circumstances under which they have been formed little obscurity prevails. I had repeated opportunities of visiting the critical sections in this neighbourhood with the late Professor Fleming, and of verifying the accuracy of his observations. I shall therefore make use of these generalised expressions in the remarks which follow.

The lowest bed of the Taragmite group which has been observed in this neighbourhood consists of loose angular fragments of rock, 2 to 3 feet thick, which rest on the edges of strata composed apparently of the same materials, and in other places of sand and gravel. The extent of this basement deposit is at present but little known. The result of three borings, shown in a diagram which is copied from one in possession of Mr George Robertson, civil engineer, proves that the basement bed of the Taragmite series is of considerable extent in the neighbourhood of Leith. Two of the borings were made for the purpose of Artesian wells, and one for the foundation of a splendid work of art, the new Graving Dock. At a flour-mill situated near the west end of Leith Docks, the section passes through 80 feet of boulder-clay, then through a bed of sand 22 feet thick, resting on the solid rocks. The excavation made for the Graving Dock passed through 24 feet of marine sand; and the boring shows that the boulder-clay is here 35 feet thick, when a bed of sand is again reached 18 feet in thickness, or 4 feet less than at the flour-mill section. At the rope-walk on the north side of Leith Links, the boring passes through a bed of marine sand 30 feet thick, then through 70 feet of boulder-clay, which at this place is found to rest on the mineralised strata, without any intervening bed of sand. Mr Milne-Home, in his "Memoir on the Lothian Coal-Fields," says, "that at Leith, and in the manufactory lately occupied by a Mr Burstall, a well was sunk through the boulder-clay 45 feet. A bed of sand and fine gravel was then reached, from which water immediately gushed up, showing that the bed was probably of considerable extent." I am informed that the boring referred to by Mr Milne-Home was made in King Street, a little to the eastward of South Leith Poorhouse; and the borings since then instituted confirm his remark, and prove

that this deposit underlying the boulder-clay is of considerable extent in the neighbourhood of Leith. This lower stratum of sand and shivers possesses a peculiar interest, inasmuch as it seems to imply that a period of time elapsed between the dressings of the rocks and their covering by boulder clay, sufficient to admit of disintegration and the formation of extensive sedimentary deposition. Additional observations on this basement bed of the Taragmite series, and its existence in other localities, are still wanted, and may assist in throwing some light on certain obscure phenomena connected with the formation of the boulder-clay—a deposit which, Dr Fleming remarks, “has been to many *pons asinorum*.” There are numerous examples where the boulder-clay is observed passing upwards into stratified beds of sand and gravel. In the foundation for the new Post-Office of Edinburgh, Mr A. Bryson and myself noticed the upper portion of the boulder-clay becoming of a light-brown colour, with an increased proportion of sand, and several horizontal layers of sand and gravel distinctly stratified, one of which, at 6 feet below the surface of the clay, was 16 inches thick, and could be traced for 20 feet.

The Akumite group in the ascending order of the superficial strata consists of three distinct kinds of deposits—silt, sand, and gravel. Sections occur in this neighbourhood to prove that, subsequent to the deposition of the Taragmite series, and previous to the commencement of the Akumite group, extensive denudation had taken place, by which the newer or upper portion of the Taragmite beds had been removed. In all the sections examined in this neighbourhood, the silt appears as the basement bed of the Akumite series, and, where present, is seen to rest immediately on the boulder-clay. There is evidence to show that in all probability the Akumite group may be regarded as a lacustrine formation, into which marine remains have occasionally been thrown by irruptions of the sea. Like the Taragmite formation, in passing upwards it graduates into sand and gravel; and where sand occurs without the boulder-clay or silt being exposed, its true relation cannot be satisfactorily determined. There are grounds for supposing that deposits of sand belonging to the

boulder-clay and silt periods have been frequently confounded with a bed of marine sand of a different origin, to which the name of raised sea-beach bed has been given. This bed belongs to the third group in the ascending scale, or Phanerite series, of the superficial accumulations; and although, as its name implies, it presents characters very distinct and easily observed, it has nevertheless formed the subject of much geological controversy.

At the concluding meeting of the Royal Physical Society for 1859, I gave a brief description of that portion of the so-called raised sea-beach bed which extends between the old sandstone quarry at Granton and the Magdalen Burn, near Fisherrow. I then stated that the lateral extent of this so-called raised sea-beach bed, and its relation to other accumulations of a similar lithological structure, but destitute of any trace of marine remains, had not yet been satisfactorily determined. The importance of this investigation will be readily admitted when it is considered that it forms, as it were, the starting point whence the great generalisations of geology begin. The raised sea-beach bed is described by Hutton, and is alluded to by his eloquent disciple Playfair, in his "*Illustrations of the Huttonian Theory*," p. 441. "The marks of an ancient sea-beach," he says, "are to be seen beyond the present limits of the tide, and beds of sea shells, not mineralised, are found in the loose earth or soil, sometimes as high as 30 feet above the present level of the sea. The ground on which the Botanic Garden of Edinburgh is situated (the Old Botanic Garden in Leith Walk), after a thin covering of soil is removed, consists entirely of sea sand, very regularly stratified with layers of a black carbonaceous matter, in thin lamellæ, interposed between them. Shells, I believe, are but rarely found in it, but it has every other appearance of a sea beach." In the "*Lithology of Edinburgh*," Dr Fleming, in reference to the remarks of Playfair, says,—"The assumption here of 'sea sand' and 'sea beach' seem alike unwarrantable from the description given of the sand; and I may add," he says, "that the occurrence of sea shells in the sand has not been since authenticated." On the high ground that extends between Granton and North Leith,

thence inland towards Edinburgh, I have had opportunities of examining numerous excavations and sections where deposits of sand and gravel are frequently exposed, without finding a trace of marine remains. These deposits constitute the upper portion of the Taragmite and Akumite series, and are extensively distributed over the surface in the vicinity of Leith and Edinburgh. The ground chosen for the various cemeteries, and for the Experimental and Botanical Gardens, is a portion of the same deposit; and the general inequality of the surface seems to indicate that the materials were assorted under the action of strong currents and eddies, in comparatively shallow water. A little to the westward of Leith Fort, there is an interesting section of the boulder-clay, known as the Man-trap, where a bed of ferruginous sand is seen resting on the clay, 15 feet above the high-water line. A short time since a cutting was made for a drain in the sloping bank, which extended from the margin of the cliff up to Anchorfield buildings. The cutting passed through 2 feet of soil, and from 2 to 4 feet of ferruginous sand, in which no marine remains could be detected. The extent of the drain, from the margin of the cliff (which is here vertical) up to Anchorfield Buildings, was 90 feet, with a rise of 5 feet. For several years past the sea has been making rapid encroachments upon this part of the coast; and there is evidence to show that, during the last forty years, 90 feet of cliff with a similar gradient has crumbled down and been removed. The bed of sand, which rests on the boulder-clay at a height of 12 to 15 feet above high-water mark, has been considered a portion of the so-called raised sea-beach bed. It would then have been 5 feet lower than at present, and, if the slope continued at the same gradient seaward, would come in contact with the ripple-zone, composed of materials similar to what is now observed at the base of the cliff. This zone extends between the limits of the high-water marks of spring and neap tides, where sands and gravel are thrown up in ridges of ever-varying elevation, and amongst which marine rejectamenta of the most varied character are to be found. The nature and contents of the present ripple-zone deposits are similar to those composing the so-called raised sea-beach bed;

and it is difficult to conceive they could have had a different origin. An attentive examination of the heterogeneous contents included in the older deposits, as exposed, for example, at the Foul Burn between Leith and Portobello, will not fail to satisfy the zoologist that the remains of molluscan life, huddled together in a bed several feet thick, could never have been associated during life. The bed is seen resting on the boulder-clay at the level of ordinary spring-tides; and at one spot is even interrupted by a slight rise in the clay of only 3 or 4 feet above the level of the tide. At this place the sea is observed to be again encroaching on the older deposits; and from observations made by my friend Mr William Young of Fillyside, it appears that 10 or 12 feet of the low cliff has fallen down during the last twelve months. Three years ago, a great abundance of living oysters were cast ashore from the oyster-bed that lies off at a short distance in one or two fathoms water. Several of our geological writers have appealed to the marine shells contained in the so-called raised sea-beach bed, to prove that a rise in the bed of the Forth has taken place within a comparatively recent geological period. In "The Lithology of Edinburgh," the instances adduced are proved to be unsatisfactory, and neither in accordance with the habits of the animals nor with the mode of distribution of the materials of a sea beach.

An attempt has lately been made to prove a rise of the coast of the Firth of Forth within the historical period, by an appeal to the so-called raised sea-beach bed deposits. It is contained in a communication by Mr Archibald Geikie, of the Geological Survey, and published in the "New Philosophical Journal" for July 1861. Mr Geikie states that he found "fragments of Roman pottery in a stratified deposit of marine silt, the deposition of which was going on during the Roman occupation of Britain." He says that "the strata with which this bed of silt is connected lie 25 feet above high-water mark, and are unequivocally those of the raised beach;" and therefore he infers that a rise in the land to this extent has taken place here since the time of the Romans.

In a communication to the Royal Society of Edinburgh by Mr A. Bryson, "On Hasty Generalisation in Geology," it was

shown that this so-called marine silt-bed* (No. 5 of Mr Geikie's diagram), supposed to be of the Roman age, contained also abundance of broken pieces of recent pottery, fragments of bone belonging to the sheep and ox, and bits of burnt coal with vesicular cavities irregularly disseminated throughout the mass. This sand-pit is situated on the south side of the Junction Road at Leith, and at the foot of Bowling Green House garden. The section in this sand-pit furnishes a remarkable instance of old artificial deposits, bearing so close a resemblance to natural beds, that experienced observers, not geologically familiar with the locality, have entirely mistaken their nature and character. I examined this sand-pit upwards of two years ago, with the view of tracing the lateral extent inland of the marine deposits. The uppermost natural deposit in the section consists of a bed of sandy clay, three or four feet thick, superimposed upon stratified beds of sand and gravel, and can be traced by its small columnar structure, due to shrinkage in drying and exposure, so characteristic of clays, as also by its light brown colour, onwards to the northern extremity of the section. This bed gradually blends with a dark unstratified mass of old humus, which, at the north end of the pit, is overlaid by a tongue of shot sand, with patches of humus intermixed, presenting an appearance of two beds that are represented in Mr Geikie's diagram as beds 5 and 6. Bed No. 7, which Mr Geikie says "is the highest in the section, and consists of stratified sand and shingle, full of littoral shells, and some balani still attached," is not seen in the sand-pit section; and the only representative that has been observed is a narrow strip of marine shingle and sand, mixed with humus, laid down at the bottom of the garden. The whole of this locality is overspread with artificial deposits. A diagram, prepared by Mr Sharbau, assistant marine surveyor, gives a correct representation of the phenomena observed in this sand-pit section. The lowest bed consists of sand and coarse shingle, and contains abundance of worn marine shells, the balani adhering to the interior of the oyster valves. This bed is four or five feet above the sea level, and its character

* This bed is not distinctly stratified. There is no trace of lamination, and there are bits of burnt coal scattered throughout the mass.

and contents are identical with a ripple-zone deposit. The overlying stratum is composed of marine sand, and varies in thickness. In this sand-pit it is five or six feet, whilst in an adjoining one, a few yards to the eastward, and now filled up, it was eleven feet thick, and contained abundance of worn marine shells and comminuted fragments. It is continuous with the bed of marine sand, in great part blown, on which the town of Leith is built, and is connected to the shore sand. This bed is frequently exposed in foundations for buildings and cuttings for drainage, and when passed through is found to rest on the boulder clay. The deposit of sand and gravel which overlies this bed in the sand-pit section is destitute of marine remains, and appears to be of fluviatile origin. It is remarkably irregular, and rises at the south end of the sand-pit into a protuberance six feet thick. The bed of marine sand disappears in the direction of the river, and the gravel is cut off to the eastward, where the overlying bed of sandy clay, and the lower bed of marine sand are observed to come in contact. This protuberance of sand and gravel extends towards the centre of the sand-pit, where a depression occurs which has been filled up with humus. This short lateral ridge of sand and gravel presents an appearance similar to what is formed by the bifurcation of rivers, or by currents heaping up deposits along their margins. The uppermost bed of sandy clay, which forms part of the so-called stratified marine silt, has all the characters of a marsh silt or lacustrine deposit; and the neighbouring hollow indicates the existence of a former lake. This is still a marsh, over which the Water of Leith occasionally flows as far as the Bonnington road; although the river is now confined within narrower limits, and guided by piers across the extensive foreshore of flat sand to its junction with the sea.

REVIEWS AND NOTICES OF BOOKS.

On the Various Contrivances by which British and Foreign Orchids are Fertilised by Insects, and on the good Effects of Intercrossing. By CHARLES DARWIN, M.A., F.R.S., &c. John Murray, London, 1862. 8vo, pp. 366.

The object of this work is to point out that the contrivances by which Orchids are fertilized are as varied, and almost as perfect, as any of the most beautiful adaptations in the animal kingdom ; and, *secondly*, to show that these contrivances have for their main object the fertilization of each flower by the pollen of another flower. This latter statement bears on the author's views, as given in his work "On the Origin of Species," that it is a universal law of nature that organic beings require an occasional cross with another individual, or, which is about the same thing, that no hermaphrodite fertilizes itself for a perpetuity of generations. In treating of the subject, the author enters into interesting details in regard to the structure of Orchids, the arrangement of the parts of their flowers, their homologies, and the varied adaptations which have been observed in their organs. He has produced a most fascinating volume, which ought to be perused by every one who wishes to understand the nature of Orchids. This extensive family embraces at least 433 genera and about 1000 species. "These wonderful, and often beautiful productions, are unlike common flowers in their many adaptations, in having parts capable of movement, and others endowed with something like, though no doubt really different from, sensibility. The flowers of Orchids, in their strange and endless diversity of shape, may be compared with the great Vertebrate class of Fish, or, still more appropriately, with tropical Homopterous insects, which seem to us, in our ignorance, as if modelled by the wildest caprice."

The author states, that his "treatise affords an opportunity of attempting to show that the study of organised beings may be as interesting to an observer who is fully convinced that the structure of such is due to secondary laws, as to one who views every trifling detail of structure as the result of a direct interposition of the Creator." In this passage he seems to us to mistake the views of those who believe that everything, however minute, must be under the direction of the Creator ; that not a sparrow, nor a hair of the head, falls to the ground without God. No one doubts the existence of what are called secondary laws, or, in other words, that the Creator chooses to work by certain great laws

which He has made and upholds every moment. These laws are but the expression of the way in which the Creator works; but it is clear that they have no independent existence; they are not self-acting, and they cannot operate except by the continued superintendence of the Lawgiver. We think that no one who reads God's Word aright can look upon the world as a mechanism set a-going by the Creator in the first instance, and then left to work out its wonders without Him; or can believe that the Creator, like a human engineer, retires from the scene, and leaves the machine to go on of itself. This is the view apparently maintained by some, and it is one which we consider irreconcilable with the statements of Holy Writ.

The parts of the flower of an Orchid are arranged in five rows, each of which consists of three parts. There are, normally, three stigmas, two of which are usually confluent, and one is modified into the rostellum; six stamens in two rows, the inner row of these (two of which are fertile in *Cypripedium*) usually abortive, and modified to form the clinandrium; the outer row of three, one being fertile and two abortive, combined with the lower petal, forming the labellum; the fourth row consists of three petals, and the fifth or outermost of three sepals. Darwin finds that there are fifteen groups of spiral vessels corresponding to these fifteen parts. An Orchid flower, according to him, "consists of five simple parts—three sepals and two petals; and of two compound parts, namely, the column and labellum. The column is formed of three pistils, and generally of four stamens, all completely confluent. The labellum is formed of one petal and two petaloid stamens of the outer whorl, likewise completely confluent. This view of the labellum explains its large size, its frequently tripartite form, and especially its manner of cohesion to the column." Such are the homologies of Orchids, and in this manner the arrangement and forms of their curiously moulded organs are explained.

The subject of Orchid fertilization has engaged the attention of many eminent botanists, such as Sprengel and Robert Brown. The nature of the pollen-masses and of their appendages, as well as the formation of pollen-tubes, and the general agency of insects, are facts which have been already recorded in various works; but it remained for Darwin to ascertain fully the mode in which insects act in the process of fertilization, as well as to show the true structure of the pollinia, and the way in which they are applied to the stigma. He has done this in a most masterly and convincing manner. His experiments are reported with great clearness and candour, and the reader is made acquainted with the difficulties which he encountered and the mode in which they were overcome. The whole is the work of a philosophic naturalist, having powers of observation of no ordinary kind, and a

wonderful facility of communicating scientific facts in an attractive and popular manner.

The phenomena of fertilization have been examined in fourteen genera of British Orchids—viz., *Orchis*, *Aceras*, *Ophrys*, *Herminium*, *Peristylus*, *Gymnadenia*, *Habenaria*, *Epipactis*, *Cephalanthera*, *Goodyera*, *Spiranthes*, *Malaxis*, *Listera*, and *Neottia*; and in forty-three exotic genera, including, among others, *Cattleya*, *Epidendrum*, *Masdevallia*, *Bolbophyllum*, *Dendrobium*, *Oncidium*, *Stanhopea*, *Calanthe*, *Angræcum*, *Acropera*, *Catasetum*. The chief facts recorded are illustrated by characteristic woodcuts.

According to the author, all the British species of *Orchis* require absolutely the aid of insects for their fertilization. This is obvious from the fact that the pollinia are so closely embedded in the anther-cells, and the disc with its ball of viscid matter in the pouch-formed rostellum, that they cannot be shaken out by violence. A list is given of twenty-three Lepidoptera which were found with the pollinia of an *Orchis* attached to their probosces. The viscid matter secreted in the disc at the foot of the pollinia adheres easily to any body with which it comes into contact, and it has the power of becoming hard during drying, so as to be firmly fixed in its position. Various means are adopted for securing the withdrawal of the pollen-masses. In some Orchids, nectar secreted in the spur of the corolla is easily obtained by moths; in such cases the pollinia are at the same time withdrawn, and their viscid disc adheres at once to the probosces. In other instances nectar is secreted between the two membranes of the spur, and in order to reach it the moth must rupture the delicate inner membrane. These phenomena seem to be connected with a difference in the viscosity and setting of the discs. In those cases where the viscid matter requires time to set and grow hard, the moths are delayed in getting nectar, so as to allow the discs to adhere to their probosces. This is a singular case of adaptation. Remarkable movements are manifested by Orchids in various parts of their flowers. The labellum of *Bolbophyllum barbigerum* is furnished with a beard of fine hairs, which causes the labellum to be in constant motion from any breath of air. In *Acropera* the labellum is articulated to the base of the column by a thin strap, so elastic and flexible that a breath of wind sets it vibrating. The Australian genus *Calæna* has a remarkably irritable labellum. When an insect lights on this labellum, it suddenly shuts up against the column, and encloses its prey as it were in a box. In *Stelis racemiflora* the little flowers are widely expanded; but after a time the three sepals close with perfect exactness, and shut up the flower, so as to appear like a bud. It is thus difficult to distinguish an old flower from a bud. The closed flower opens under water. Numerous are the movements shown by the pollinia. In *Dendrobium chrysanthum* the anther has a peculiar spring-

ing action, by which it scoops the pollen-mass out of the concave clinandrium, and pushes it up in the air with exactly the right force, so as to fall in the middle of the viscid stigma, where it sticks. In many *Vandææ* the pedicel of the rostellum has a strong natural elastic tendency to spring up at right angles to the disc; in other cases, hygrometric movements are seen. As regard the movements of the pollinia in British *Ophreæ*, these are "due to the nicely regulated combination of that small portion of membrane (together with the pedicel in the case of *Habenaria*) lying between the layer or ball of adhesive matter and the extremity of the caudicle. In most of the species of *Orchis* the stigma lies directly beneath the anther-cells, and the pollinia simply move vertically downwards. In *Orchis pyramidalis* and in *Gymnadenia* there are two lateral and inferior stigmas, and the pollinia move downwards and outwards, diverging at the proper angle (by a different mechanism in the two cases), so as to strike the two lateral stigmas. In *Habenaria* the stigmatic surface lies beneath and between the two widely-separated anther-cells, and the pollinia here again move downwards, but at the same time converge."

The mode in which insects act in the case of *Orchis pyramidalis*, is thus described:—"Let a moth insert its proboscis between the guiding ridges of the labellum, or insert a fine bristle, and it is surely conducted to the minute orifice of the nectary, and can hardly fail to depress the tip of the rostellum; this being effected, the bristle comes into contact with the now naked and sticky under-surface of the suspended saddle-formed disc. When the bristle is removed, the saddle with the attached pollinia is removed. Almost instantly, as soon as the saddle is exposed to the air, a rapid movement takes place, and the two flaps curl inwards and embrace the bristle. When the pollinia are pulled out by their caudicles, by a pair of pincers, so that the saddle has nothing to clasp, I observed that the tips curled inwards, so as to touch each other in nine seconds; and in nine more seconds, the saddle was converted, by curling still more inwards, into an apparently solid ball. The probosces of the many moths which I have examined, with the pollinia of the *Orchis* attached to them, were so thin, that the tips of the saddle just met on the other side. This rapid clasping movement helps to fix the saddle with its pollinia upright on the proboscis; but the viscid matter rapidly setting hard would probably suffice for this end, and the real object gained is the divergence of the pollinia. The pollinia being attached to the flat tip or seat of the saddle, project at first straight up, and are nearly parallel to each other; but as the flat top curls round the cylindrical and thin proboscis, or round a bristle, the pollinia necessarily diverge. As soon as the saddle has clasped the bristle, and the pollinia have diverged, a second movement commences; which

action, like the last, is exclusively due to the contraction of the saddle-shaped disc of membrane. The second movement causes the divergent pollinia, which at first projected at right angles, to the needle or bristle, to sweep through nearly 90 degrees towards the tip of the needle, so as to seem depressed and finally to lie in the same plane with the needle. This second movement was often effected in thirty or thirty-four seconds after the removal of the pollinia from the anther-cells. The object of this double movement seems to be, to allow the ends of the pollinia to touch the double stigmatic surface, when the proboscis of the insect is pushed between the guiding ridges of the labellum into the nectary of the same or another flower. These stigmas are so viscid, that they rupture the elastic threads by which the packets of pollen are bound together; and some dark-green grains will be seen, even by the naked eye, remaining on the two white stigmatic surfaces."

The phenomena connected with the fertilization of *Listera ovata* may be given as another illustration. They are thus summed up:—"The anther-cells open early, leaving the pollen-masses quite loose, with their tips resting on the concave crest of the rostellum. The rostellum then slowly curves over the stigmatic surface, so that its explosive crest stands at a little distance from the anther; and this is very necessary, otherwise the anther would be caught by the viscid matter, and the pollen for ever locked up. This curvature of the rostellum over the stigma or base of the labellum is excellently well adapted to favour an insect striking the crest when it raises its head, after having crawled up the labellum, and licked up the last drop of nectar at its base. The labellum becomes narrower where it joins the rostellum, so that there is no risk of the insect going too much to either side. The crest of the rostellum is so exquisitely sensitive, that a touch from a most minute insect causes it to rupture at two points, and instantaneously two drops of viscid fluid are expelled, which coalesce. This viscid fluid sets hard in so wonderfully rapid a manner, that it rarely fails to cement the tips of the pollinia, nicely laid on the crest of the rostellum, to the insect's forehead. As soon as the rostellum has exploded, it suddenly curves downwards till it projects at right angles over the stigma, protecting it in its early state from impregnation, in the same manner as the stigma of *Spiranthes* is protected by the labellum clasping the column. But as in *Spiranthes* the labellum after a time moves from the column, leaving a free passage for the introduction of the pollinia, so here the rostellum moves back, and not only recovers its former arched position, but stands upright, leaving the stigmatic surface, now become more viscid, perfectly free for pollen to be left on it. The pollen-masses, when once cemented to an insect's forehead, will generally remain firmly attached to it,

until the viscid stigma of a mature flower removes these encumbrances from the insect, by rupturing the weak elastic threads by which the grains are tied together, receiving at the same time the benefit of fertilization."

In the case of another genus, *Catasetum*, the author points out a series of remarkable phenomena. In these plants, some mechanical aid is required to remove the pollen-masses from the receptacle, and to carry them to the stigmatic surface. Some of the species, such as *Catasetum tridentatum*, *C. saccatum*, and *C. callosum*, are unisexual, and require that the pollen-masses should be transported to the female plant, in order that seed may be produced. *Catasetum tridentatum* presents three forms—1. The ordinary male form; 2. The female form, which has been named *Monacanthus viridis*; 3. The hermaphrodite form, called *Myanthus barbatus*. These three sexual forms are borne on separate plants, but sometimes they are mingled together, so that the plant becomes Polygamous. The three forms are wonderfully different from each other. In the male and hermaphrodite flowers, irritable antennæ (tubular horn-like processes, formed by prolongations of the anterior face of the rostellum) are present, which are specially adapted to receive and convey the effects of a touch to the disc of the pollinium; causing the membrane to rupture, and the whole pollinium to be ejected by its elasticity. If we required further proof, nature has afforded it in the case of the so-called genus *Monacanthus*, which is the female plant of *Catasetum tridentatum*, and has no pollinia to eject—and here the antennæ are entirely absent.

"When the left-hand antenna of *Catasetum saccatum* (or either antenna of *C. tridentatum* and *C. callosum*) is touched, the edges of the upper membrane of the disc, which are continuously united to the surrounding surface, instantaneously rupture, and the disc is set free. The highly elastic pedicel then instantly flirts the heavy disc out of the stigmatic chamber with such force that the whole pollinium is ejected, bringing away with it the two balls of pollen, and tearing the loosely attached spike-like anther from the top of the column. The pollinium is always ejected with the viscid disc foremost." The pollen-mass is sent out with considerable force, sometimes even to the distance of two or three feet. The viscid matter sets hard, and firmly fixes the winged pedicel to the insect's body. The insect then flies from flower to flower till at last it visits a female or hermaphrodite plant; it then inserts one of the masses of pollen into the stigmatic cavity. When the insect flies away, the elastic caudicle, made weak enough to yield to the viscosity of the stigmatic surface, breaks, and leaves behind the pollen-mass; then the pollen-tubes slowly protrude, penetrate the stigmatic canal, and the act of fertilization is completed. How interesting and surprising are these complex and admirable arrangements.

Self-fertilization is a rare event with Orchids. In *Cephalanthera grandiflora* it occurs, but in a very imperfect degree, and the early penetration of the stigma by the flower's own pollen-tubes seems to be fully as much determined by the support thus given to the pillars of pollen, as by the production of a small proportion of seed; certainly the fertilization of this orchid is favoured by insects. In some species of *Dendrobium* self-fertilization apparently occurs; but only if insects accidentally fail to remove the flower's own single pollen-mass. In *Cypripedium*, the Frog Orchis, and perhaps in a few other cases, it will depend on the manner (at present unknown) in which insects first insert their probosces by the one or the other entrance, whether the flower's own pollen, or that of another flower, is habitually placed on the stigma; but in these cases there will assuredly always be a good chance of the stigma being fertilized by pollen brought from another flower. In the *Ophrys apifera* alone there are special and perfectly efficient contrivances for self-fertilization. "In this Orchid the caudicles are very slender; the mother-cells naturally open, and the masses of pollen, from their weight, slowly fall down to the exact level of the stigmatic surface, and are thus made to vibrate to and fro by the slightest breath of wind, till the stigma is struck. This phenomenon seems to be plainly adapted in this instance for self-fertilization. Hence, in this species, all the capsules are frequently perfected. At the same time there are manifest adaptations in this Orchid for the occasional transport by insects of the pollinia from one flower to another, as in the other species of the same genus." Darwin thinks that Nature tells us in the most emphatic manner that she opposes perpetual self-fertilization. He has endeavoured to prove this in the case of many other plants besides Orchids, and even in plants which are hermaphrodite, such as species of *Primula*. The conclusion at which he thus arrives is considered by him of vast importance, and as justifying the ample details given in this volume. "For may we not infer as probable," he says, "in accordance with the belief of the vast majority of the breeders of our domestic productions, that marriage between near relations is likewise in some way injurious; that some unknown great good is derived from the union of individuals which have been kept distinct for many generations?"

In reviewing all the variations which occur in the flowers of Orchids, the author thinks that "the simple and intelligible view is, that all Orchids owe what they have in common to descent from some monocotyledonous plant, which, like so many other plants of the same division, possessed 15 organs, arranged alternately 3 within 3, in five whorls; and that the now wonderfully changed structure of the flower is due to a long course of slow modification,—each modification having been preserved which was useful to each plant during the incessant changes to which the

organic and the inorganic world have been exposed." If we had every Orchid which has ever existed throughout the world, he supposes that "every gap in the existing chain, and every gap in many lost chains, would be amply filled up by a series of easy transitions." The more he studies nature, the more he is convinced of the correctness of his conclusion, "that the contrivances and beautiful adaptations are slowly acquired through each part occasionally varying in a slight degree, but in many ways, with the preservation or natural selection of those varieties which are beneficial to the organism under the complex and ever-varying conditions of life."

The connection between certain tribes of insects and orchids is well shown in the case of the beautiful Madagascar plant called *Angræcum sesquipedale*. This plant has a whip-like green nectary, 11 or 12 inches long, with the lower part only filled with nectar, and requiring visits from insects with very long probosces. In collecting the nectar, the insect requires to insert its proboscis up to the very base through the cleft of the rostellum, and by this means provision is made for the attachment of the pollinia to the proboscis during its withdrawal. The author remarks that, if the *Angræcum* in its native forests has its nectary filled more than in the specimens he examined, then small moths might obtain their share of the nectar, but the pollinia would not be moved, and thus fertilization would not be effected. The pollen-masses can only be withdrawn by means of an insect with a wonderfully long proboscis, trying to drain the last drop of nectar. "If such great moths were to become extinct in Madagascar, assuredly the *Angræcum* would become extinct. On the other hand, as the nectar, at least in the lower part of the nectary, is stored safe from depredation by other insects, the extinction of the *Angræcum* would probably be a serious loss to these moths. We can thus partially understand how the astonishing length of the nectary may have been acquired by successive modifications. As certain moths of Madagascar became larger through natural selection in relation to their general conditions of life, either in the larval or mature state, or as the proboscis alone was lengthened to obtain honey from the *Angræcum*, and other deep tubular flowers, those individual plants of the *Angræcum* which had the longest nectaries, and which consequently compelled the moths to insert their probosces up to the very base, would be best fertilized. These plants would yield much seed, and the seedlings would generally inherit longer nectaries; and so it would be in successive generations of the plant and moth. Thus it would appear that there has been a race in gaining strength between the nectary of the *Angræcum* and the proboscis of certain moths; but the *Angræcum* has triumphed, for it flourishes and abounds in the forests of Madagascar, and still troubles each moth to insert its

proboscis as far as possible, in order to drain the last drop of nectar."

In these passages we see the bearing of the facts of Orchid fertilization on the production of new forms, as propounded by the author in his work on the "Origin of Species." He traces all modifications through successive generation, and thinks that this is a better view of the case than to suppose that the Creator at once called into existence the varied forms of the present flora. He thinks that if we could trace back floral forms from generation to generation for long epochs, extending it may be over millions of years, we would be able to account for all variations in a more philosophic manner than by referring them to one creative fiat of the Almighty. He deprecates the idea of M'Cosh and others, that in these modified forms of great types the Creator displayed the plan and order of His work, and that in the abnormalities in the forms of organs and their gradation God has shown the principles of His arrangement, and has developed the workings of His all-creative mind. For our own part, we do not see the great superiority of the Darwin view over this latter hypothesis. Both are no doubt theoretical. The obstacles to the reception of Darwin's hypothesis in its full extent are great. To believe that all the forms of animals and vegetables spring from a cell, which through countless millions of ages has undergone an infinite series of transformations by natural selection, correlation of growth, struggle for life, &c., is certainly not an easy thing for the mind, more especially when *man* is included in the category. Here it is that the difficulty occurs; and it is precisely at this latter stage that the opponents of Darwin's views have a sure foundation to rest upon. For here Revelation steps in, to tell us of man's creation, of his relation to the Deity, of his present fallen condition, and of his future prospects, and speaks in such terms as to preclude the possibility of our adopting the Huxleyan view that, as the lowest ape, in the conformation of its skeleton, differs as much from the highest ape as the latter does from man, therefore we are merely transformed apes.

In his work on Orchids, however, Darwin does not stretch his view to this limit. He details facts with the utmost candour, and then very plausibly shows how they might be accounted for on his view of transmission by generation. Setting aside all theory, and looking at the work in itself, we have no hesitation in saying, that it is one of the deepest interest, well worthy of being studied; that it presents forms and functions to us under new aspects; illustrates in no ordinary degree the beautiful adaptations which are seen in plants, and is calculated to exalt our ideas of the wonder-working Jehovah.

Volcanos: the Character of their Phenomena, their Share in the Structure and Composition of the Surface of the Globe, and their Relation to its Internal Forces; with a Descriptive Catalogue of all known Volcanos and Volcanic Formations. By G. POULETT SCROPE, M.P., F.R.S., F.G.S., &c. 2d Edition, revised and enlarged, with a Map of the Volcanic Areas of the Globe, &c. London: Longman & Co., 1862. 8vo. pp. 490.

The study of the subterranean forces which have everywhere broken up the rocks of the globe and altered their composition, is one of great interest and importance. The manifestations of these forces are distinguished in the phenomena of earthquakes and volcanoes. "The first are, to outward apprehension, purely dynamical, consisting in sudden and transient *shocks* and wave-like vibrations of extensive superficial areas, attended by fracture, disturbance, and often permanent change of level in their component rocks. The latter are characterised by *eruptions*,—that is, the forcible expulsion of heated matters, gaseous, fluid, or solid—(usually all these together)—from the interior of the earth upon its surface, these phenomena being very generally accompanied or preceded by earthquakes of a minor and local character." These two kinds of subterranean action are probably modifications of the same force, acting from different depths and under different circumstances. The author distinguishes between plutonic and volcanic action, and differs from Humboldt in his view of the latter. He gives a general view of volcanic action, and points out the connection between earthquakes and volcanic eruptions. He gives the localities of volcanos, their number and geographical position, and illustrates the latter by a map. The phenomena of ordinary subaërial eruptions are considered under three phases:—1. That in which the volcano exists incessantly in outward eruption,—phase of permanent eruption. 2. That in which eruptions, rarely of any excessive violence, continue in a comparatively tranquil manner for a considerable time, and alternate with brief intervals of repose,—phase of moderate activity. 3. That in which eruptive paroxysms of intense energy alternate with lengthened periods of complete external inertness,—phase of prolonged intermittences. "The main agent in all these stupendous phenomena—the power that breaks up the solid strata of the earth's surface, raises, through one of the fissures thus occasioned, a ponderous column of liquid mineral matter to the summit of a lofty mountain, and launches thence into the air, some thousand feet higher, with repeated explosions, jets of this matter, and fragments of the rocks that obstruct its efforts—consists unquestionably in the expansive force of some elastic aëriiform fluid struggling to escape

from the interior of a subterranean body of *lava*,—that is, of mineral matter in a state either of fusion, or at least of liquefaction, at an intense temperature. This body of lava is evidently, at such times, in *igneous ebullition*. That it conducts itself, on obtaining access to the outer air through some crevice sufficiently widened for this purpose, precisely after the manner of a boiling liquid or paste, has been ascertained by repeated observations." By the rapid, continuous, and explosive discharge of steam-bubbles ascending from some depth within lava which has forced its way up some fissure to the outer surface, this orifice is gradually enlarged, the intercepting matter blown into the air, and a crater formed of varying magnitude. At first, pieces of broken rocks are ejected; these are followed by jets of liquid and incandescent matter, accompanied with ragged fragments torn off from the solid crust. The force is so great that a rock weighing 200 tons has been sent up to a height of several hundred feet into the air. The author gives the following account of the phenomena connected with eruption:—"Some of the more liquid portions of the lava shot up assume, by rotation through the air, a globular or pear-shaped figure. These are the volcanic *bombs* often found in the vicinity of an eruptive vent; and, as they can only be produced in the manner here indicated, their occurrence on any spot affords a useful indication of the site of an eruption at some former period, when other signs are perhaps wanting—as in *Monts Dore* and *Cantal*. Their nucleus is usually compact, and sometimes consists of a solid fragment of some earlier rock caught up and enveloped in the liquid lava; but towards the surface they have a vesicular envelope beneath an outer shell of compact texture. In size they vary from that of the largest block in a man-of-war's rigging to that of a nut or almond. The great bulk of the ejected fragments of lava, cooling rapidly in their passage through the air, possess ragged, tattered shapes, and when examined are found to be full of vesicles. Those of the heavier ferruginous lavas are called *scoriæ*, from their resemblance to the cinders, or slags of iron-furnaces. The *scoriæ* of the felspathic lavas, which have an inferior specific gravity, are usually still more vesicular or filamentous, and have a vitreous fracture. They are called *pumice*. In some cases, where the lava is peculiarly tenacious and tough, it is drawn out into filaments, having a silky lustre almost equal to that of *asbestos*. As the eruption progresses, the surface of the lava sinks within the vent more or less rapidly, owing either to its outflow from some orifice at a low level in the flank of the volcano, or to the exhaustion of the subterranean eruptive energy by loss of heat through the amount of vapour discharged from it Of the smaller fragments ejected vertically from an eruptive vent, those which, by their mutual friction in the air, have been reduced to a sort of

gravel of rounded scorix, are called *lapillo* by the Italian geologists,—a word sometimes corrupted into *rapilli*; when, by still further attrition, they are comminuted into sand, *puzzolana*; and when brought to the condition of fine dust, *cineri* or *ashes*. The *lapillo* is generally of a deep black colour; the *puzzolana* is red, like burnt brick-dust; the fine ashes are of a whitish grey."

The phenomena connected with lava are considered by the author in reference to its emission, its outflow, its progression and coagulation, the forms it assumes, the rents and caverns which are seen in it, the dykes and columns which it forms, and the metamorphic action which it exerts. The mineral characters and constitution of lava-rock, of trachyte, basalt, and traps, in all their varieties, and the mode in which volcanic mountains are formed, are fully considered. A chapter is devoted to craters on volcanic mountains, cones of different kinds, volcanic islands, crater lakes, solfataras, craters of the moon, and lunar volcanos. The lunar craters, compared with those of the earth, are more generally distributed, deeper, and of greater diameter. They appear to have been formed by the explosions of vapour breaking through a surface of soft and semifluid matter in successive bubbles, and throwing off all round a concentric ridge formed of repeated layers of the substance.

Besides subaërial volcanos there are others formed under water, and termed *subaqueous*. Instances of submarine eruption have been observed off St Michael one of the Azores, in the Grecian Archipelago, off the coast of Iceland, among the Aleutian group of islands, off the south-west coast of Sicily, on the coast of New Grenada near Carthage, as well as on the west coast of Africa, and the east coast of South America. "In all these submarine eruptions, volumes of smoke (steam mixed with ash) by day, and flames (jets of red hot scorix) by night, were seen to rise from the sea, which was considerably agitated, discoloured, and heated to such a degree as to kill a number of fish." The dark island rocks afterwards showed themselves above the sea level, and either remained as permanent volcanic islands or disappeared. Coral islands are in many instances raised on lava rocks.

The consideration of the relation between plutonic and volcanic action, and the subject of metamorphic rocks, leads the author to the following general conclusions in regard to telluric phenomena:—1. The earliest condition of the lowest known matter of the globe is that of a granitoid triple mineral compound, consisting generally of felspar, quartz, and mica; the mica being at an intense temperature, and in a state of violent elastic tension, and thus pressing forcibly on the overlying substance. 2. The highest layers of this matter, acted upon by upward pressure, have acquired a more or less laminar arrangement of their component crystals, and have been split and penetrated by the intrusion of

more liquid matter beneath, and have often been forced up the axial fissure in a folded and crumpled manner. 3. Fissures formed by these disturbances, opening downwards into the heated lava or granitic matter, have been filled with matter which, on consolidation, produced a plate or dyke of crystalline igneous rock. 4. The jar accompanying the rending of such fissures, and the injection of heated matter into it, occasion an undulatory vibration in the adjoining masses of solid rock, producing the effect of an earthquake shock. 5. When the crevice penetrates to a focus of liquefied igneous matter, it occasions the formation of a dyke; and when the matter is sent up into the atmosphere or shallow water, it enters into violent ebullition, causing a volcanic eruption. 6. The lava so erupted is sometimes in a complete state of glassy fusion, but more usually in one of more or less imperfect crystallisation, mixed with interstitial heated water or steam, the escape of which hastens the consolidation of the matter and the formation of lava rock. 7. The erupted matters consolidate in the form of a conical mound over the vent—the orifice whence the eruptive explosions proceeded being marked by a saucer or cup-shaped crater; and by the accumulation of repeated ejecta, a volcanic mountain is formed. 8. These outward eruptions are accompanied or followed by subsidence or upheaval of the surrounding area. 9. The cause of these changes in the earth's crust appear to be the unequal transmission through it of heat from beneath upwards; and this heat, varying in different parts, gives rise to the phenomena of elevation and subsidence. 10. The cause of the internal heat of the globe is still undetermined; the author does not consider it to be due to oxidation of any metallic nucleus, nor to the generation of electric currents within the globe; but he inclines to the supposition of a gradually cooling nucleus, still retaining much of the intense temperature possessed by it at the time of its original formation.

“The theory suggested above as to the emanation of the central heat, not only provides a reasonable origin for plutonic upheavals and the formation of fissures and faults, but also for the occasional extravasation and ebullition of some portion of the subterranean mineral matters (known, as far as we are acquainted with them, to contain water), which increased temperature or diminished pressure has liquefied and caused to effervesce. It moreover accounts for the relative geographical position of the elevated ranges and the eruptive ones. One hypothesis alone suffices to explain the whole series of terrestrial phenomena—elevations and subsidences in mass, earthquake shocks, and volcanic eruptions, as well as their mutual relations,—that hypothesis being the shifting of the flow of heat (which we know to be continually rising out of the interior of the earth) from one subterranean mass of mineral matter to another.

"It has been shown that such a shifting is not only probable but inevitable, through the ever-varying capacities for the conduction of heat of those areas of the globe which are respectively sub-aërial and subaqueous—variations that must necessarily arise from the varying influences of the oceanic, meteoric, and organic forces.

"This theory seems to me to explain both the plutonic and the volcanic phenomena better than any other, and the harmony and general accordance of all its parts is the best test of its truth."

In an Appendix, the author gives a catalogue and description of volcanos now or recently in activity, with some account of earlier volcanic formations. In this last he includes the volcanos of Europe, those of the Levant, Asia, the Eastern and Western Atlantic, the Southern Ocean, South America and Eastern Pacific, Central America, North America, Western, Southern, and Central Pacific.

We have thus endeavoured to give a brief abstract of the valuable facts in regard to volcanos, as given in Mr Scrope's book. The work is most ably written, and it is one of great interest alike to the general reader and to the geologist. The details are given in a clear manner, and the more important are illustrated by an excellent series of woodcuts. The subject of volcanos must necessarily command the attention of all who study the history of our globe. The awe which they inspire, the overwhelming convulsions which they cause, the awful destruction which they occasion, and the terrific phenomena which accompany their eruptions, cannot fail to make them objects of deep interest. They proclaim the existence of igneous matter in the interior of the solid earth, and they seem to point to the period when the earth and all things therein shall be dissolved, and when the elements shall melt with fervent heat.

The Student's Manual of Geology. By J. BEETE JUKES, M.A., F.R.S., Local Director of the Geological Survey of Ireland. A new Edition; partially recast, and supplied with Lists and Figures of Characteristic Fossils. Edinburgh: A. & C. Black. 1862. 8vo. Pp. 764.

This appears to us to be the best Manual of Geology in the English language; and we are glad to see that a second edition has been called for, and that the author has made important additions and improvements. In these days, when geology occupies an important place in education, it is necessary that the student should be supplied with a condensed view of the great facts of the science, and that he should be properly directed in his researches. These objects are fully attained by the present compact volume, which can be put into the hands of students with the utmost con-

fidence, as being the work of an eminent geologist, who has been long engaged in the practical details of the science, and who possesses the power of communicating information in a clear and interesting manner.

The work is divided into three parts :—

I. *Geognosy*, or the study of the structure of rocks, independently of their arrangement into a chronological series. This is subdivided into—1. *Lithology*, or the study of the internal structure, the mineralogical composition, the texture, and other characters of rocks, such as could be determined in the closet by the aid of hand-specimens ; 2. *Petrology*, or the study of rock-masses, their planes of division, their forms, their positions and mutual relations, and other characters, that can only be studied in the field, but without entering on the question of the geological time of their production.

II. *Palæontology*—The study of the laws which have governed the distribution of life, both in space and in time, and the consideration of the chief points in the structure of the more important extinct races, and their relations to those now living.

III. *History of the Formation of the Crust of the Globe*, including chronological classification, the history of the principal and typical groups of rocks known to have been produced, and an account of some of the more common and best-marked fossils which lived at different parts of the earth during each of the known great periods of its existence.

Under the head of *Lithology* are considered the subjects of chemistry and mineralogy, rock-forming minerals, origin, classification, and determination of rocks, igneous, aqueous, aerial, and metamorphic. Under the head of *Petrology* are included, the formation of rock-beds and rock-blocks, disturbance in the earth's crust, inclination of beds, faults, dislocation, cleavage and foliation, denudation, unconformability, granitic, trappean, volcanic rocks, Orography, or the structure and origin of mountains, mineral veins, and the art of mining. Under *Palæontology*, the author considers Zoology and Botany, and the laws and generalisations of *Palæontology*. The third part contains accounts of the formation of the Palæozoic, Mesozoic, and Cainozoic epochs. An Appendix contains remarks on geological surveying. The Index contains an explanation of words derived from the Latin and Greek, and the pronunciation of the words is indicated.

In speaking of the practical importance of fossils, Mr Jukes makes the following observations :—

“ The importance of the study of fossils to all those who wish not only to learn the past history of life upon the globe, but to understand the problems involved in its present multiplicity of form and variety of diffusion, will be obvious even from the slight and hasty observations that precede. Their importance, however,

is not limited to the theoretical speculations, or the philosophical conclusions that may be derived from them, for those, like many other scientific conclusions, may be coined into actual money, or money's worth, by their practical application.

" If in any particular part of the earth beds of any substance of economic value to man were formed during a particular geological period only, it is obvious that those beds, and the others in which they lie, will contain the remains of the animals and plants that lived during that period, and no others. If, therefore, the valuable beds be but a few thin seams occurring here and there in a great series, and our object be to discover where any part of that series reaches the surface, in order that we may search for the valuable beds, it is clear that the fossils will be of the greatest assistance to us.

" The mere lithological character of the other beds of the series may be of little or no use to us as a guide, and may even mislead us, since there may be other series having beds of precisely similar character, but not containing the valuable beds.

" The most striking instance of what is here stated generally, is the occurrence of beds of coal in the part of the series which is hence called the Carboniferous formation. Coal is not confined to that formation, since in different parts of the world good workable coal occurs in other formations; but, in Britain and Western Europe, although thin beds of coal occur in other formations, extensive beds of workable coal have only been found in the Carboniferous formation. Coal is usually associated with black and grey shales in that formation, and the same association occurs in other formations, where the coal is too impure or in too small quantity to be valuable. Black and grey shales also occur in parts of the Carboniferous series, where there is no coal, and in other formations entirely devoid of coal. The coal miner being always accustomed to see coal associated with black and grey shale, and not having had occasion, like the geologist, to see black and grey shales in other formations, naturally looks upon the occurrence of the black and grey shale as indicative of the presence of coal. The geologist, on the other hand, having a wider experience, knows, that not only do black and grey shales occur where there is no chance of coal being found, but that even thin seams of coal occur in formations where no coal worth working has ever been found in the British area or in Western Europe.

" He therefore knows, that all 'indications' are worthless as evidence of the presence of the 'Carboniferous formation,' except the occurrence of the 'Carboniferous fossils.'

" Even where the fossils occur there may be no coal, but all sinking for coal in beds containing any other than the Carboniferous fossils is pure waste of labour and money.

" Within my own experience large sums of money have been

absolutely thrown away, which the slightest acquaintance with palæontology would have saved. I have known, even in the rich coal district of South Staffordshire, shafts continued down below the Coal-measures deep into the Silurian shales, with crowds of fossils brought up in every bucket, and the sinker still expecting to find coal in beds below those Silurian fossils. I have known deep and expensive shafts sunk in beds too far above the Coal-measures for their ever being reached, and similar expensive shafts sunk in black shales and slates in the lower rocks far below the Coal-measures, where a pit might be sunk to the centre of the earth without ever meeting with coal. Nor are these fruitless enterprises a thing of the past. They are still going on in spite of the silent warnings of the fossils in the rocks around, and in spite of the loudly-expressed warnings of the geologists, who understand them, but who are supposed still to be vain theorists, and not to know so much as 'the practical man.'

"I have elsewhere stated my belief that the amount of money fruitlessly expended in a ridiculous search after coal, even within my own experience, would have paid the entire cost of the Government Geological Survey of the United Kingdom. It is a curious perversity of the human mind, that men prefer to take the advice of those whose interest it is to get them to spend money, rather than the warnings of those who can have no interest in inducing them not to spend it."

Genera Plantarum, ad Exemplaria imprimis in Herbariis Kewensibus servata, definita. Auctoribus G. BENTHAM et J. D. HOOKER. Voluminis Primi, Pars I., sistens Dicotyledonum Polypetalorum Ordines LVI. (Ranunculaceas—Connaraceas). Londini, 1862. Royal 8vo, pp. 454.

The work of Endlicher, having a similar title, was long the chief authority in regard to the genera of all known plants. During the life-time of the author, it was kept up to the state of science by the publication of supplements; but after his death, it was allowed to fall behind the demands of the botanical world. The work was also deficient in many points, both as regards arrangement and definitions. There was a want of a complete work on genera—one drawn up by a botanist of decided eminence and authority, in which the characters would be given in a terse and clear manner, and in which the definitions would be founded on the examination of a large collection of specimens from all quarters of the globe. The present publication most effectually supplies this desideratum. It is the result of the united labours of two of the most distinguished botanists of the age, who have travelled much and seen the Floras of various parts of the world,

and who have had the advantage of the admirable collections of Kew, which are probably the largest in the world. They have brought to bear on the subject extensive practical knowledge and philosophical acumen of no ordinary kind; and they have produced a standard work, which, while it will add to their renown, will at the same time be hailed by every botanist as one of the greatest boons which the science has received.

The authors tell us that Linnæus was the inventor of genera, and that they have therefore neglected all the so-called generic names before the time of Linnæus, and which have not been adopted either by him or by subsequent authors. They have attributed the generic name either to Linnæus or to the author by whom it was first used according to the Linnean rule. They mention the work in which the genus was first named, either by Linnæus or by those after him. They also quote the volume of Decandolle's *Prodromus* or of Walper's *Supplements*, in which there is the most recent enumeration of the species; and they indicate also other works, in which new and remarkable species are described, as well as some of the best drawings to be consulted. Synonymes are carefully given, and the generic characters have been verified in general by the examination of several species. Doubtful genera are enumerated, but those which have been rashly adopted, and which have not been properly described, are omitted. The first part of the work embraces the Polypetalous Dicotyledons, from Ranunculaceæ to Connaraceæ inclusive. A conspectus is given of Polypetalous Dicotyledons. These are divided into three series: 1. *Thalamifloræ*—Calyx very generally free from the ovary, petals in one, two, or numerous rows; stamens indefinite or definite, inserted often on a small or elevated or stalk-like torus; ovary very frequently superior. 2. *Discifloræ*—Calyx often free from the ovary; petals in one row; stamens more commonly definite, inserted within or above or round a torus, which is commonly expanded into a disc; ovary usually superior or immersed in a disc. 3. *Calycifloræ*—Tube of calyx often embracing the ovary or adnate to it; petals in one row, inserted into the calycine tube; stamens indefinite or definite, very often inserted into the calyx tube, or into the disc lining the calycine tube; ovary often included in the tube of the calyx, or inferior.

Under the Thalamifloral series there are six cohorts: Ranales, Parietales, Polygalineæ, Caryophyllineæ, Guttiferales, Malvales. Under the Discifloral series there are four cohorts: Geraniales, Olacales, Celastrales, Sapindales. As anomalous orders, or rather genera, are given, Coriariæ and Moringææ. The order Connaraceæ belongs to the Calycifloral series, a conspectus of which will be given in the next part. Under each order there is a valuable conspectus of the genera, with an indication after each genus of the country or countries in which the species chiefly

occur. At the head of each page the order and the tribe are printed, so as to allow of easy reference. Among the changes which have been made as to the usually recognised orders, the following may be mentioned:—Calycanthaceæ are placed as Order III., between Dilleniaceæ and Magnoliaceæ; Schizandræ are put as a tribe of Magnoliaceæ; Lardizabaleæ as a tribe of Berberidæ; Cabombaceæ and Nelumbiaceæ as tribes of Nymphæaceæ. Under Papaveraceæ we have Fumariæ as a sub-order; Pangieæ are a tribe of Bixiæ; Reaumuriæ and Fouquieriæ are tribes of Tamariscinæ; Rhizoboleæ, Marcgraviæ, Saurajæ, and Bonnetiæ, are considered as tribes of Ternstrœmiaceæ; Buettneriæ are put as a tribe of Sterculiaceæ; Prockieæ and Elæocarpeæ are tribes of Tiliaceæ; Hugoniæ, Erythroxyleæ, and Ixonanthæ, are tribes of Linæ; Limnanthæ, Vivianiæ, Wendtiæ, Oxalidæ, Balsaminæ, along with Tropæolum, are included under Geraniaceæ; Rubiaceæ include Cuspariæ and Zanthoxyleæ, Toddaliæ and Aurantiæ; Meliaceæ include Cedreleæ; Hippocratiæ are a tribe of Celastrinæ; while Elæodendreæ are a sub-tribe of the same order; Acerinæ, Dodonæ, Melianthæ, and Staphyleæ, are tribes of Sapindaceæ; an order Sabiaceæ is defined, including the genera *Sabia*, *Theleosma*, *Phoxanthus*, and *Ophiocaryon*.

It is impossible to enter upon detailed notices of the genera. The definitions of them are given with great skill and discrimination. There is no tendency to split up and multiply genera. Much judgment, on the contrary, is displayed in uniting, in place of separating, species, genera, and orders. The book will be invaluable to practical botanists, and it will form an indispensable companion of those who are engaged in botanical explorations in every quarter of the globe. We shall look anxiously for its completion, and in the meantime we must congratulate the authors on the successful issue of the First Part of this *Opus Magnum*.

PROCEEDINGS OF SOCIETIES.

Botanical Society of Edinburgh.

Thursday, 8th May, 1862.—Professor BALFOUR, V.P., in the chair.

The following communications were read:—

1. *On the plentiful occurrence of Buxbaumia aphylla (Haller) in Aberdeenshire.* By WILLIAM SUTHERLAND, M.A.

The suspicion entertained by many muscologists that this interesting moss is of far more general occurrence, in favourable situations, than the paucity of stations hitherto given for it would indicate, has

lately received ample confirmation in this district. Mr Wilson in his "Bryologia" gives twelve localities, two of which are in England. Since the species was many years ago recorded by Mr Jackson as found "near Aberdeen," two additional localities have been discovered in our country; first, some years ago, but very sparingly, near Ballater, by Mr Cruickshank, and last year in great abundance by Mr Coutts in various places on the hills in the parishes of Towie and Cushnie. These hills lie about thirty miles west of Ava, and about ten miles north of Ballater, the river Don flowing immediately to the north of them. In August last I had the pleasure of visiting the principal of these stations, which is situated in a slight depression near the northern summit of the range, and found that here, over a considerable space of ground, the heather had been recently burned, and had but very sparingly regained its footing. In the bare places, and little ledges of peat, all over this tract, the *Buxbaumia* occurred in more or less abundance, either singly or in groups of from two to six, while, besides the fully-formed capsules, I noticed many little green ones just appearing above ground, cylindrical in form, and with somewhat of the general appearance of a *Splachnum*. On the 12th November last I had occasion to examine two pieces of turf, each $1\frac{1}{2}$ by 1 foot in surface area, which had been sent to Professor Dickie, and on one of these were no less than 49 specimens *in situ*, while the immature capsules seen in August had all attained the normal shape and size, but still remained green in colour. From this circumstance I am inclined to think that this species begins to fruit in the summer or early autumn months, and is not fully ripe until the next spring, having spent the intervening winter under a mantle of snow.

2. On the Occurrence of *Isoetes echinospora* (Durieu), in Scotland. By WILLIAM SUTHERLAND, M.A.

One of the most interesting botanical localities near Aberdeen has always been the Loch of Drum (or Park), and now it has the additional attraction of being at present the only station known in Scotland for the new species of *Isoetes*, recently established or proposed by M. Durieu. Although Professor Babington has had under examination specimens of this genus from most of the Scotch localities, all these were found to belong to *I. lacustris*, with the exception of the few specimens sent by me, and which had been collected in the Loch of Drum. The commoner species also grows there, and that, too, probably in greater abundance. It appears that the intended monograph on *Isoetes* by M. Durieu has not yet been published, and therefore no detailed description can be referred to at present,* though no doubt can be entertained of the fact of its occurrence here, as judging from a specimen sent him by Professor Babington, he has given the Loch of Park as a new station for it, in a recent number of the *Bulletin de la Soc. Botanique de France*. Professor Babington has found the species in Wales. It differs from *I. lacustris* in its generally smaller size, more spreading and robust habit, and yellowish green colour. I take the liberty of giving Professor Babington's general description of the spores, as kindly communicated to me:—"If you look at the larger spores in a dry state, and before they have been removed from the cases in which they lie, you will see that they are covered with very fine spines; in *I. lacustris* they bear blunt but rather high tubercles. The spines, and indeed the tubercles also, are so easily broken that they seldom remain perfect upon spores removed from their case."

* The plant is now described in Professor Babington's Manual. Fifth edition, just published.

3. *Notes on Cuckoo-flowers and the Cuckoo-spit.* By JAMES HARDY, Esq., Penmanshiel.

(This paper appeared in the July number of the Journal.)

4. *Notice of Adelges piceæ of Ratzeburg.* By JAMES HARDY, Esq.

In a letter to Professor Balfour, Mr Hardy says—"I see by the report of last meeting of the Botanical Society that a supposed *Coccus* is infesting the silver firs about Alloa. This, I apprehend, will be the *Adelges picea* of Ratzeburg, specimens of which I enclose, rather more advanced than those seem to have been which were sent by Mr Dawson, and examined by Mr W. R. M'Nab. It is closely allied to the species found on the twigs of the larch, *Adelges laricis*. It is most hurtful to young trees, by destroying the leading shoots; on the trunks of old trees it will remain for years without visibly impairing their vitality, and one tree will continue infested while a long avenue will remain clean. It probably occurs more or less in every collection of silver firs. Mr Andrew Murray sent me specimens from Kinross-shire several years since, and I had others from Roxburghshire from the late Rev. James Duncan. There is another so like this, on the bark of the Scotch pine, that I cannot observe any difference in wingless specimens. It is the *Adelges corticis* of Kaltenbach. It has come from the nurseries on young trees; I have not seen it prove fatal in this vicinity. The larch *Adelges* began to excite notice in the country about 1814, as appears from the thirteenth vol. of the 'Bath Society's Papers.' It is now found on almost every tree, and yet the larch continues to flourish."

5. *Notice of an Ash Tree struck by Lightning near Edinburgh.* By Mr M'NAB. (Plate IV.)

On Thursday the 1st of May at 10 P.M., a severe thunderstorm passed over the south side of Edinburgh, damaging a large ash tree standing on the grass lawn half way between the porter's lodge and the dwelling-house at Moredun, three miles from Edinburgh, the seat of David Anderson, Esq. The tree seems to have been struck by the electric fluid about 40 feet above the ground, at the point where the stem divided into branches. A portion of the west side of the tree is entirely torn away to the depth of 6 inches and 2 feet broad, proceeding from the top to within 3 feet of the ground, at which point the stem is 10 feet 4 inches in circumference. The portions torn from the tree were thrown to various distances, some as far as 212 feet. One piece, 6 feet long and about 6 inches in diameter, was thrown 180 feet distant. The fragments averaged 120 in number, varying from 6 inches to 8 feet in length, and were scattered more or less all round the tree, the heaviest portions being towards the north; several had their ends stuck deep into the ground. The pieces as they now lie scattered about, all denuded of their bark, have more the appearance of being blown into their present grotesque positions with gunpowder than by a stroke of electricity. (See Plate.)

Dr A. Christison sent from India a specimen of *Allosorus nitidulus*, Presl., a rare fern, which he had collected in Kooloo in a solitary spot.

Thursday, 12th June 1862.—Professor BALFOUR, V.P., in the Chair.

The following communications were read:—

1. *Remarks on the Nature and Peculiarities of the Fern spore.* By JOHN SCOTT, Royal Botanic Garden.

(This paper appears in the present number of the Journal.)

2. *Gleanings among the Irish Cryptogams.* No. I. By BENJAMIN CARRINGTON, M.D., F.L.S., &c.

Introductory Remarks.—Killarney is professedly a place of autumnal resort. There are few visitors before the beginning of July. Why this should be is hard to say, for nothing can be more varied and lovely than the early summer tints; nothing sweeter than the songs of summer birds; and the only period almost uniformly free from rain is that from April to June. I was unable to obtain accurate statistics of the rain-fall, but in Galway, in 1861, it was upwards of 57 inches—24 inches falling between July, and September.* The proportion is still greater in the mountain regions of Kerry, and many a visitor has found the meaning of the lines:—

"Thy suns with doubtful gleam
Weep while they rise."

If the botanist desires to pursue his calling unmolested by crowds of visitors, and picturesque but pestiferous beggars, he should reach Muckross in May. Most of the distinctive plants of the district are then in perfection; he will find the hotels empty, and landlords and guides ready enough to oblige him.

It would be vain to attempt a description of these famous lakes. I have visited most of the English lakes, and the more beautiful scenery of Loch Lomond and the Trossachs; but there is a fulness of beauty, and enchantment about Killarney, which surely exists nowhere else. Like the author of the "*Irish Sketch Book*," we felt inclined to pronounce "each of the lakes in turn the most beautiful, and so at every point we stopped at, we determined that that particular spot was the prettiest in the whole lakes." It is only gradually, as day by day the mind drinks in the varied loveliness of colour and outline, that we are able to form a critical judgment of the whole. The mountains which enclose the lakes on either hand, are less remarkable for height than for gracefulness of form. The culminating peaks of Mangerton, and Carron Tual, measure respectively 2756 feet, and 3414 feet. The geological features of the district are worthy of study. On the eastern shores we find scars of carboniferous limestone, strangely honeycombed, and worn into most fantastic shapes by the action of the waves. Underlying these are dark slaty strata, like the Silurian rocks beneath the limestones of Craven. Further west the mountains divide, forming bold headlands between the indented bays of Dingle and Bantry, and are for the most part composed of shales, and conglomerates of the Old Red system. But the rugged skeleton of the rocks only peeps out here and there; the general surface is clothed with a "pomp of groves," and an exuberance of vegetation only equalled in the isles of the Southern Ocean. Many hills, such as Torc, Cromaglan, and Glenna, are covered from the water's edge to the very summit, with a continuous forest. Near the summit, the heather, 6 or 8 feet in height, mingling with trees and shrubs, forms an almost impenetrable barrier. The trees are of various kinds—oak, beech, and ash predominating. There are some lofty pines on the Torc mountain, and the yew, and holly are not uncommon. Solitary trees of the former occur of great age. The ivy luxuriates everywhere, hanging pendant from the trees, or covering rocks and walls with its dark lustrous foliage. But the plant which will possess most novelty to the botanist is the *Arbutus Unedo*. It is found both on the islands and shores of the lakes, but nowhere in great abundance. In size and form it is not unlike an apple tree, with a smooth cinnamon-coloured stringy bark, and shining rhododendron-like leaves.

It is interesting to note how the introduction of one species like the *arbutus*, and the prevalence of other evergreens, alter the tone of the woods, giving them a sub-tropical aspect. Even in winter they must be very beautiful. There is some danger that this interesting species, like the *Trichomanes*, may become exterminated before very long by the rapacity of the guides. Young plants are now extremely rare, and when found are invariably taken and sold to visitors. As it is a tender plant, most of these perish in English gardens. The young *arbutus* resembles the *rhododendron*, and I was informed that some of the guides keep a supply of slips of the latter, and pass them off for the true plant. While upon this subject, I may state, with a regret which all true botanists will share, that the *Trichomanes brevisetum*, not many years ago the gem of the Torc and other ravines, is now nearly extinct in the Killarney woods. I searched for it many a day in places where it once abounded, but without success. It has been in such request with the fern collectors, that the guides are constantly on the look-out, and when a tuft is found, they exterminate it root and frond. Patches are still brought from the distant ravines above Glencoe.

Although vegetation is so profuse, the number of flowering plants about Killarney is probably smaller than in any area of like extent in England. We miss the various introduced species, colonists, escapes from gardens, from corn-fields, and viatical plants.

Still more remarkable, considering the elevation of the land, is the entire absence of the Highland type of flora. On much lower hills in England and Wales, many subalpine species are met with. This fact would seem to militate against the theory of Forbes, and to indicate some ancient communication with the Spanish coast, rather than with those of Britain. Nor do we find the absence of accustomed forms compensated by many indigenous species. The greatest novelties are the saxifrages, represented by *Saxifraga Geum*, and *S. umbrosa*, their starry blossoms forming a conspicuous object by the wayside. Tufts of *Euphorbia hibernica* were often met with, as was also that floral gem of Killarney, *Pinguicula grandiflora*, in fine blossom early in June. Few plants excel it in delicacy of form, and intensity of colour. The waters abound with lacustrine species. Among them I observed a peculiar variety of *Nymphaea alba* with crisped leaves, and a form of *Nitella flexilis* with dense, distant whorls of capsules, looking to the naked eye like balls of gooseberry pulp, an exquisite object under the microscope. But the real attraction of the south-west of Ireland consists in the variety of its cryptogamic flora. Those accustomed to observe mosses and lichens in England can form no idea of their luxuriance and beauty there. They form so considerable a proportion of the entire vegetation, as to give a peculiar type to the scenery, obvious even to the uneducated eye. Many rare species will be met with on banks and walls. The trunks of trees are often hidden beneath an eruption of strange forms—crustaceous and frondose lichens—great purple patches of *Frullania*, and other *Hepaticae*, and a variety of mosses.

On young oaks, growing with *Orthotrichum Drummondii*, *O. crispum*, *O. phyllanthum*, &c., I was fortunate enough to secure a supply of a new species, *Ulotia calvescens*, with the calyptra almost smooth. It was first collected by my friend Mr D. Moore, but the specimens were immature, and both Mr Wilson and M. Schimper passed it over as a form of *O. crispum*.

On leaving the roadside we are at once shut out by the foliage from the external world, and only catch an occasional glimpse of the lakes from some ledge of rock. Ascending over rocks literally paved with cryptogams, new and unaccustomed forms continually meet the eye of the

botanist—*Hypnum micans*, *H. demissum*, and *H. eugyrium*, and a crowd of hepaticæ, and lichens. Thus he passes on in a whirl of wonder and excitement, until the shades of evening warn him to return. The only drawbacks are the heat of these close coverts, and the swarms of gnats which assault all who invade their humid domains. This plenitude of cryptogamia seems due, less to the equability of the climate, than its extreme humidity. The warm air, laden with the vapours of the Gulf-stream, meets its first barrier in the mountains of Kerry. On looking at a physical atlas, it will be seen that the zone of greatest moisture passes through the south-west of Ireland, then crossing the Channel, intersects a portion of Devon and Cornwall. In connection with this fact, we may state that many of the rarer Irish cryptogams reappear again in Cornwall—viz., *Dumortiera* (*Marchantia*) *irrigua*, *Blyttia hibernica*, *Phragmicoma Mackaii*, *Lejeunia minutissima*, *L. calyptrifolia*, *Frullania fragilifolia*, and such mosses as *Hookeria late-virens*, *Campylopus polytrichoides*, and *Bartramia rigida*.

Although I devoted six weeks to Killarney, so thoroughly has the district been examined, that I met with few novelties. My investigations will rather tend to reduce the number of species adopted by Dr Taylor, and others. The finding new species in our day must be a rare circumstance; but every botanist may add something to the common stock of knowledge, by finding new stations, and by testing the permanency of specific forms, and the limits of variation.

Dr Douglas MacLagan stated to the meeting that, in examining the ovaries of *Richardia æthiopica*, he found them to contain abundance of acicular crystals or raphides, and starch granules,—the former being 1-1000th of an inch in length, and the latter 1-6000th of an inch in breadth. By chemical analysis he ascertained the crystals to be composed of oxalate of lime and not phosphate of lime.

Professor Balfour announced that General Grey had transmitted to the Museum at the Botanic Garden, by command of the Queen, a collection of Scotch Alpine flowers, modelled in wax. The flowers are some of those found in the neighbourhood of Balmoral, and they have been modelled by Miss Matheson of Aberdeen. Their names are as follow:—*Calluna vulgaris*, common heather or ling; *Erica cinerea*, fine-leaved bell heath; *Erica Tetralix*, cross-leaved bell heath; *Vaccinium Myrtillus*, bilberry or blaeberry; *Vaccinium Vitis-Idæa*, red whortleberry, flower and fruit, the fruit of this plant is usually called cranberry in the Highlands; *Arctostaphylos Uva-ursi*, red bearberry; *Empetrum nigrum*, black crowberry; *Rosa canina*, dog rose; *Rubus cæsius*, dewberry; *Potentilla reptans*, creeping cinquefoil; *Campanula rotundifolia*, round-leaved harebell; *Bellis perennis*, common daisy. The flowers are neatly arranged on a small rockwork of granite, which is raised on an oval pedestal of imitation granite. The whole is covered by a bell-jar, and the date is marked "June 1862."

Dr Greville exhibited roots of New Holland acacias which emitted a strong garlic odour. He stated that while repotting a number of these plants he found the same strong garlic smell to be given off by twenty different species.

William A. Stables, Esq., sent specimens of *Pinguicula alpina*, from the Black Isle, Ross-shire, accompanied by the following note:—"I was lately in the vicinity of the habitat of *Pinguicula alpina*, and send you herewith a few dried specimens. I have sent a few roots at the same time to the Botanic Garden. The station is woefully encroached upon by the plough, a very small corner of it indeed being left. One outlying portion

of the habitat, and the first I came to, afforded no specimens at all—the marsh being converted into square fields, on which large bullocks were grazing. The progress of improvement along the ‘Millbuy’ is very great, and will, I fear, soon remove *P. alpina* from the list of British plants.”

A letter was read from Mr John Sim, in which he mentioned that he had found *Claytonia alsinoides* in great abundance, along with *Asperula taurina*, *Symphytum officinale*, *Valeriana pyrenaica*, *Doronicum plantagineum*, &c., by the side of a small stream in the woods of Murrayshall, about three miles east of Perth. On Moncrieffe Hill, near Bridge of Earn, he had also met with the following plants:—*Asperula taurina*, *Doronicum pardalianches*, *D. plantaginea*, *Anchusa sempervirens*, *Allium scorodoprasum*, and *Scrophularia vernalis*.

The following note from John Anderson, Esq., Perth, was read:—“I enclose a very singular shoot from the plant known as *Taxus japonica* or *Cephalotaxus Koriana*, which proves it not to be a distinct species as described, but a sub-variety of *Cephalotaxus drupacea*, or Fortune’s female variety.”

Lieutenant William Jardine, of H.M.S. Nile, sent specimens of foliage, fruit, and wood of the Bermuda cedar (*Juniperus bermudiana*), from Bermuda.

Thursday, 10th July, 1862.—Professor BALFOUR, V.P., in the Chair.

The following communications were read:—

1. *List of Arctic Cryptogamic Plants, &c., collected by ROBERT BROWN, Esq., during the Summer of 1861, on the Islands of Greenland, in Baffin’s Bay and Davis Straits, and presented to the Herbarium of the Botanical Society.*

(The Plants were determined by Mr JOHN SADLER.)

In this paper the author gave an account of a scientific voyage, during the year 1861, to the seas round Spitzbergen, Jan Mayen, and Greenland, describing the structure of the various islands of Davis’ Straits and Baffin’s Sea (Bay), as illustrating the nature of their flora. In addition to several mosses and lichens rare to the Arctic Flora, he had discovered *Laminaria longicruris* of De la Pylaie’s Flora of Newfoundland, for the first time, as occurring plentifully within the Arctic circle; and *Melobesia calcarea*, hitherto only recorded from Spitzbergen, for the first time, in Davis’ Straits (Haven Island, four fathoms.)

No. 1. Collected on the Big Duck Island and Duck Islands Baffin’s Bay, June 8–11, 1861.

Stereocaulon paschale.
Cladonia uncialis.
 papillaria.
Cetraria islandica.
 nivalis.
Parmelia parietina, var.
 saxatilis.
 omphalodes.
 conspersa.

Lecanora tartarea.
 ventosa.
Gyrophora hirsuta.
Cornicularia ochroleuca.
 bicolor.
Pogonatum alpinum.
Bryum caespitium.
Hypnum aduncum.



No. 2. Collected on one of the Browne Islands, Women's Islands, Baffin's Bay, off North Greenland, lat. $74^{\circ} 7'$, long. —; primary rocks and boggy wet soil almost wholly composing the islands. June 5, 1861.

Several species of <i>Stereocaulon</i> and	<i>Pogonatum alpinum</i> .
<i>Cladonia</i> .	<i>Hypnum uncinatum</i> , var.
<i>Dicranum Richardsoni</i> ?	<i>Hypnum</i> , sp.
<i>Aulacomnion turgidum</i> .	<i>Urceolaria scruposa</i> .

No. 3. From Hare Island, west coast of Greenland; lat. $70^{\circ} 43' N.$; long. $55^{\circ} 42' W.$; greenstone, gneiss, and other rocks, jutting out above the snow. 27th May 1861.

<i>Bryum nutans</i> .	<i>Gyrophora proboscidea</i> .
<i>Cornicularia bicolor</i> .	<i>proboscidea</i> , var.
<i>pubescens</i> .	<i>Cetraria nivalis</i> .
<i>Lecidea rupestris</i> .	<i>Lecidea geographica</i> .
<i>petraea</i> .	var. <i>apicula</i> .
<i>Gyrophora arctica</i> .	<i>Parmelia caperata</i> .
<i>hyperborea</i> .	<i>olivacea</i> .

No. 4. The following were the only flowering plants seen, and brought home intermixed with the mosses.

<i>Salix lapponum</i> . In all the islands.	<i>Silene acaulis</i> . Duck Islands.
<i>Stellaria humifusa</i> . Duck Island.	<i>Empetrum nigrum</i> . Duck Islands.
<i>Saxifraga rivularis</i> . Duck Islands.	<i>Poa alpina</i> . Browne Island.
<i>Papaver nudicaule</i> . In all the islands.	<i>danica</i> . Browne Island.

2. *Remarks on some Fibrous Plants of Canada.* By GEORGE LAWSON, Ph. D., Professor of Chemistry and Natural History in the University of Queen's College, Kingston, Canada.

All the excitement of late years, in regard to Fibre Plants, has had but little practical effect in Canada. It is certainly remarkable that a country whose soil and climate are so suitable for the growth of Fibre Plants should be still so little known in European commerce as an exporter of fibres. However, we are not entirely without progress in this department. Within the last year or two the exertions of our agricultural societies have resulted in the somewhat general cultivation of flax, although still in restricted quantities, throughout various parts of Upper Canada. The flax produced is of very good quality, and has met with approval in England and Scotland, especially in the Dundee market, where flax is the staple manufacture. It appears to me that the chief obstacle to the universal cultivation of flax, and the introduction of some other improvements in this country, is to be found not so much in the high rate of wages as in the collateral expenses of hired field-labour; for unfortunately our farmers have none of the advantages of the bothy system, but have to make provision in their own houses for the farm-labourers of so extravagant a kind as virtually to throw the majority of farmers back upon the labour of their own families.

Under such circumstances, it is not to be wondered if our progress in the cultivation of a crop like flax, requiring so much field-labour, should be slow. On the other hand, Fibre Plants of easy cultivation, with little labour, would hold out a strong inducement. I suspect that the key to our successful production of fibre in large quantities is to be found in the culture of perennial plants, which require less labour and care. We have many such among our indigenous plants capable of producing fibres,—*Urticaceæ*, *Apocynaceæ*, and *Asclepiadaceæ*, all easy of cultivation in our

soil and climate, and capable of holding their own against the inroad of weeds.

In the Botanic Garden, now in course of formation here, we are collecting the various fibre plants suited to the climate, with a view to experiment, and hope ere long to publish the results. In the meantime I enclose a few samples of Canadian fibres, and copy of correspondence on *Asclepias* cotton and *Asclepias* flax, in which some members of the Botanical Society of Edinburgh may possibly feel an interest, after the suggestive papers of Dr Alexander Hunter and Dr Cleghorn on the Fibre Plants of India. I ought to mention farther, that common hemp is obviously suited for successful cultivation in this country.

COMMUNICATION FROM HIS EXCELLENCY LORD MONCK, ON A FIBRE PLANT
SUITED TO THE CLIMATE OF CANADA.

- (1.) *Letter from DENIS GODLEY, Esq., His Excellency's Secretary, to Professor LAWSON, Secretary of the Botanical Society of Canada.*

QUEBEC, May 16, 1862.

SIR,—I am directed by the Governor-General to transmit to you herewith a copy of a letter which was addressed to Lord Lyons by Doctor Hart, and which Lord Lyons forwarded to His Excellency.

Some of the seeds of the plant to which Doctor Hart alludes are also enclosed.

His Excellency thinks it likely that the Botanical Society of Canada, of which you are Secretary, may be interested in this matter, and will cause the seeds to be sown with a view to testing the value of the plant bearing them.—I have the honour to be, &c.

DENIS GODLEY, *Governor's Secy.*

George Lawson, Esq., &c. &c. &c.

- (2.) *Letter from FREDERIC W. HART, M.D., St Louis, to the LORD LYONS.*

ST LOUIS, May 1, 1862.

MY LORD,—Feeling that Her Majesty's Government is deeply interested in the cultivation of cotton in the British Provinces, and having, during a sojourn in the Rocky Mountains these last three years, discovered a plant that excels cotton in length of fibre or staple, firmer in texture, and fine as silk, I determined to plant a few seeds taken from the wild plant, and last year found, to my satisfaction, that the seed-vessels, which in the wild plant are about the size of hen eggs, under culture grew to the size of a turkey or goose egg, and bore twice the quantity of silk that the Mississippi plant bears of cotton.

I gathered four pounds of the silk from the plant, and saved a quantity of the seed, some of which I herewith forward you.

On my return in January last to the United States, I was robbed by the Indian Kiowas on the plains. They stole my silk but left my seed.

The silk weed of the Rocky Mountains grows on the creek bottoms, pushes out in June, and ripens in September, October, and November.

It is about five feet high. It does not branch in the wild state, but its branches under cultivation, and bears full of large bolls or pods.

The seed is all on the *outside* of the silk, and slips off at a touch, leaving the most beautiful silk I ever saw.

It can be cultivated on the St Lawrence bottoms, Canada; and in Upper Canada the whole country is suitable for its cultivation, the climate being similar and even warmer than that of the localities where I discovered the plant.

As an old cotton planter of Mississippi, having raised ten crops in Yazoo, my brands invariably commanding the highest market price, I feel the fullest confidence in recommending this seed to the attention of Her Majesty's Government for cultivation in the Canadas.

Should your Lordship require further information on this subject, I shall be happy to continue this correspondence.—I remain, &c.

(Signed) FREDERIC W. HART, M.D.

The Lord Lyons, &c. &c.

- (3.) Letter from Professor LAWSON, Secretary of the Botanical Society of Canada, to DENIS GODLEY, Esq., Secretary to His Excellency LORD MONCK, Governor-General of Canada, &c. &c.

KINGSTON, May 22, 1862.

SIR,—I had the honour to receive your letter of 16th May, with accompanying copy of letter addressed to Lord Lyons by Dr Hart, of St Louis. And I have to request that you will convey to His Excellency Lord Monck, the best thanks of the Members of the Botanical Society for the information which he has done them the honour to communicate, and for the accompanying seeds.

I have also to state that, in accordance with His Excellency's wishes, the seeds have been sown in the Botanic Garden here, with a view to testing the value of the plant as a source of fibre. The crop will be watched with care, and duly reported upon to His Excellency, so soon as the results can be obtained.

In the meantime, it may be desirable to indicate briefly the probable character of the plant, and what likelihood there is of its becoming useful.

An examination of the seeds shows Dr Hart's Fibre Plant to be an *Asclepias*, of which genus there are many species, inhabiting different parts of the American continent, all producing a greater or less amount of fibrous material, usually of great beauty and lustre; and fibre-yielding plants of allied genera occur in India and elsewhere.

The beautiful silky material contained in the seed-pods of *Asclepias* has necessarily attracted attention in this as in other countries, but, as attempts to spin it failed, its use in the arts has hitherto been confined to the stuffing of pillows and beds, and such like purposes, among the settlers. There is every reason to believe, however, that the silk-cotton of our *Asclepias* may now be economised for spinning purposes, and therefore a greater interest is to be attached to Dr Hart's plant at the present time than would have been necessary a few years ago.

The results of experiments that have been made in India, and by manufacturers in England, with the silk-cotton obtained from an allied plant, the *Calotropis gigantea*, or Mudar Plant of Bengal (which is essentially an *Asclepias*), offer inducements to attempt the raising of *Asclepias* fibres in Canada. The silk-cotton of the Mudar Plant is now becoming an article of export from India for the manufacture of a light substitute for flannel, and has been employed by Messrs Thresher & Glennie, of London, for this and other manufactures, as appears from the remarks of Dr Alexander Hunter, made at a meeting of the Madras Agri-Horticultural Society on 15th January last. The Mudar material works well with either silk or cotton, and is now known in commerce as Mudar Silk-Cotton. There is no reason whatever why the silk-cotton of Dr Hart's plant, and the silk-cotton of our indigenous Canadian *Asclepiads*, should not prove as applicable to the purposes of the manufacturer as the silk-cotton of India.

It is desirable to observe that the silk-cotton found in the pod of *Asclepias* represents only half its riches as a fibre plant. A beautiful and apparently very valuable fibre is also obtained from the stem, which I am inclined to regard as of even greater importance than the silk-cotton itself. It is of quite a different character from that found in the pods, being not cottony, nor so glossy, but of much greater strength, resembling, in fact, not cotton, but flax. One of our Canadian species, *Asclepias incarnata*, has been experimentally cultivated with a view to the production of fibre, and the results of the experiments have been given by Judge Logie in the second part of the Botanical Society's Annals, page 87. Specimens of the fibre were exhibited by Mr Freed to the Hamilton Association in 1860, and the Report of Mr M'Miking, a paper manufacturer, is given in Judge Logie's paper, showing the fibre to be strong, flexible, silky, of a beautiful high colour, brilliant lustre, and easily bleached—in fact, too good for paper-making, but of undoubted utility and value as a fibre. This species is still under experiment in the Botanic Garden here.

The success that has attended the use of the Mudar flax in India (as well as the Mudar cotton) seems also to hold out a strong inducement to the use of *Asclepias* flax in this country. The Mudar flax, from its tenacity, is called "Bowstring Hemp" in India, and is one of the strongest fibres known. Dr Hunter, who has carefully studied the vegetable fibres of India for many years, states that it possesses most of the qualities of flax, and can be worked with the same machinery, as the fibre splits to almost any degree of fineness with the hackle, and bears dressing and beating well. For many years it was employed by the wealthy natives in India for making strong cloths, cambrics and lawns, worn by the rajahs; and it is still employed for making fishing lines, nets, gins, bow-strings, and tiger-traps, on account of its strength. It does not rot readily in water, as the resinous milky juice of the plant seems to preserve it.

Other Indian *Asclepiads* likewise yield fibre of great strength, which seems to be partly due to the presence in the plant's juice of an organic product similar in physical properties to caoutchouc or gutta percha.

Judging from the observations and experiments of Dr Hart on the silk-cotton plant found by him on the Rocky Mountains, and from the results of experiments that have been made by others on allied species—on *Asclepias* flax in Canada, and on *Asclepias* cotton and flax in India,—it is not unlikely that both *Asclepias* flax and *Asclepias* cotton may ultimately become important materials of export from Canada. The *Asclepiads* grow luxuriantly in a wild state throughout Canada, especially in the western parts; and, being strong-growing perennial plants, they are capable of easy cultivation, and would require not a tithe of the field labour necessary for the growth of common flax.

Permit me farther to mention that, in addition to the seeds sown in the Botanic Garden, some have also been sent to members of the Botanical Society, in other parts of Canada, for trial, and copies of your communication, with Dr Hart's letter, have been furnished to the members, with a view to inquiry, and to observation and experiment on Dr Hart's *Asclepias*, as well as on the indigenous species of our country.—I have the honour to be, Sir, your most obedient humble servant,

GEORGE LAWSON, PH.D., LL.D.,
Secretary to the Botanical Society of Canada.

Denis Godley, Esq., Secretary to
His Excellency Lord Monck,
Governor-General of Canada.

3. *Gleanings among the Irish Cryptogams.* No. II. By BENJAMIN CARRINGTON, M.D., F.L.S., &c.

I have already noted the abundance of cellular plants in the south-west of Ireland, tracing it to the prevailing humidity of the climate.

These plants, which occur everywhere, from the sea-level to the mountain top, impart a surprising freshness and greenness to many districts, and justify the name of the *Emerald Isle*. But as it is natural to associate the ideas of verdure and plenty, strangers are apt to form an erroneous estimate of the richness of the soil. The cryptogams are mostly epiphytic in habit; they ask little more than a surface to grow upon, and abundant moisture. However interesting to the botanist, it must be confessed they represent a low type of development, and form an unprofitable, if not unwholesome, kind of vegetation. Meantime, in these days of drainage, the student will appreciate as it deserves such a field of research as Killarney. We cannot always trace the true relations and uses of objects, and are too ready to consider everything worthless, and unworthy attention, that does not administer directly to our wellbeing. That the Creator has bestowed such care upon the structure and preservation of these plants, should teach us they were not made in vain. How many secrets of life and development their translucent tissues have revealed! And what a multitudinous series of forms they assume; what adaptability to extremes of climate, and wonderful powers of reproduction! Even in an æsthetic point of view they claim no mean place. The ferns are universal favourites; but few reflect how much of the beauty of rock or ruin,—of gnarled trunk or wave-worn cliff,—is due to cryptogamic plants. Artists have not studied as they might have done, those touches of colour, white and red—golden and purple—the wrinkles, and “time stains” of the ages gone by. Strip the ruin of these, and you efface all that told of the past and made it venerable.

Of modern writers, Wordsworth, and Ruskin alone seem alive to these influences.

“The gentler work begun
By nature, softening and concealing,
And busy with a hand of healing,—
The altar, whence the cross was rent,
Now rich with mossy ornament.”

The Cryptogamia attain their culmination in Ireland for the Northern, as they seem to do in New Zealand, for the Southern hemisphere, where, from the insular character of the land, and the moist atmosphere of the southern ocean, similar conditions prevail. A comparison between the two floras presents us with one of those examples of representative distribution so interesting to the naturalist.

	Ireland.	New Zealand.
Lichens, . . .	295	150
Mosses, . . .	230	250
Hepaticæ, . . .	88	190
	613	590

This table is not very recent, but will be found relatively correct. It will be observed how closely the numbers correspond. Many are common to both countries, and the majority belong to the same genera. The abundance of Hepaticæ in New Zealand is compensated by the number and beauty of Irish lichens.

Of the eleven weeks of my stay in Ireland, nearly six (May 11th to June 18th), were spent at Killarney. The four succeeding weeks were

devoted to sea-bathing at Ross Bay; and the last week we visited Glasnevin, and Dublin.

Ross Bay is a primitive bathing hamlet at the head of Dingle Bay. I was induced to prefer it rather than Bantry, because the district was unexplored. But upon examination I found there was little to discover. The hills are composed of a loose Old Red conglomerate, with uniform rounded contours, and destitute of trees, which add so much to the charm of Killarney. Still, the bay was very fine, and a narrow isthmus of sand dunes, which extends nearly to the northern shore, formed a capital strand, and perpetual barrier to the Atlantic swell.

Algae were very abundant, many of great rarity; and such gigantic Laminariæ, and great tufts of Rhodospiræ, I never saw before. After a storm the beach was literally piled with them, and scores of people were employed carting them away. They form the only manure used in this district, and, indeed, the only riches the natives derive from this rich bay. The staple, of course, is the potato, which flourishes wonderfully under this treatment. There are no kitchen or flower gardens about Irish cottages. If we wanted a salad, fruit of any kind, or the commonest pot herb, we had to send to Killarney, more than twenty miles; and even there, they could only be obtained from the gardens of the gentry. How the people exist without these, to us, indispensable necessities, I cannot tell. But they seem too apathetic and indolent to cultivate anything but what will barely keep body and soul together. Who can wonder there should be chronic famine in the west of Ireland? Until they learn to develop the resources of sea and land, and are taught the benefits of horticulture and husbandry, no legislation can aid them. Once create the desire for other diet than potatoes, and one of the greatest difficulties would be overcome.

In lieu of better employment, we spent much time in boating, and shooting inoffensive penguins and gulls. The white breast of the gull was in great request for ladies' plumes, and it was my task to preserve them. I met here again that curious amphibian the natter-jack, (*Bufo calamita*); it is a pretty harmless creature, and its bell-like chorus at eventide could be heard at a great distance. I had previously observed it among the sand-flats of Southport, a very similar habitat.

By far the larger portion of my collections were made at Killarney. Two or three times a week I made excursions, seldom beyond six miles from Mucross, into the woods. The best spots were the Torc Mountain, Cromaglan, and the Eagle's Nest; and weeks might be devoted to any one of these without exhausting it.

The stillness of these woods is almost oppressive, only broken by the alarm note of some startled bird, or the continuous hum of clouds of gnats, which I found almost as tormenting as the mosquitoes of South America. On one occasion, near the summit of Torc, I met with a rather unpleasant adventure. Depending from twigs of broom, I saw what appeared a tissue-paper balloon, and wondering how it reached such a place, I unthinkingly tore it open, but in a moment an angry buzz warned me that I had invaded a wasp's nest. Fortunately the density of the shrubs which made the ascent so laborious, now proved my salvation; for leaping and rolling down the steep sides of the mountain, I soon outstripped pursuit.

There is one spot I think of with peculiar pleasure—the Torc or Turk Cascade, made classical by the researches of Mackay, Taylor, Wilson, and many others. It was only about half a mile from the hotel, and almost every evening we strolled there. Ascending a short ravine covered by trees, we reach a sunken amphitheatre of rocks, down which the tumultuous water flows. Here, on spray-moistened boulders, and the steep sides of dripping rocks, we behold the perfection of cryptogamic life.

Noble ferns droop from the fissures, mosses of many kinds fringe the rocks, or cover them with a glossy, many-coloured pile. The colours of some species are very rich and characteristic; thus, *Hypnum eugyrium*, (which here replaces *H. palustre*), occurs in wide patches with a coppery lustre. The fronds of *Hypnum demissum*, and *H. flagellare* are golden, and those of *Hookeria lucens*, pale and silvery. But the Hepaticæ claim precedence for the number and beauty of their species. Depending from the dripping ledges are large tufts of *Frullania Hutchinsiae*, and *Anema pinnatifida*. *Plagiochila punctata*, *P. tridenticulata*, and *Lepidozia tumidula*, grow on trees and rocks. Parasitic on other species, we find *Lejeunia ovata*, *L. hamatifolia*, and *L. microscopica*; whilst *Radula voluta*, *Phragmicoma Mackaii*, *Frullania fragilifolia*, and a host of others, will repay careful research. But the pride of Tore Cascade, and perhaps one of the finest species in the world, is *Dumortiera irrigua*. (*Marchantia*, Tayl.) It grows on the steep faces of rocks, in patches of several yards in diameter, and nothing can surpass the gracefully scalloped outlines, and dark velvety greenness of the fronds. The effect is heightened by the beads of spray which cover the surface with a translucent film, like so many pearls. Unfortunately it shrinks in drying, and the expressive form and colour are lost.

It will be observed that the list of Hepaticæ is relatively more perfect than the other orders. The fact is, my chief object in visiting Ireland, after the renovation of health, was the collection and study of that group. The eye sees what it is trained to see, and this will account for my overlooking some rare lichens, and mosses; whereas, with the exception of *Gymnanthe Wilsoni*, *Syn. Hep.*, I got all the rarer Hepaticæ. Descriptions of several species will be found in the following catalogue, not hitherto recorded as British.*

List of Lichens collected at Killarney, from May 11th to June 18th, 1861.

This collection represents very inadequately the Lichenological riches of Killarney. It comprises only the more conspicuous species; those growing on rocks were purposely omitted, from their bulk and weight. I am indebted to Mr W. Mudd for the determination of these plants, and the nomenclature is that of his work on British Lichens (1861). Whatever may be the difference of opinion as to the value of the genera adopted, there can be none as to the great labour and research, and practical acquaintance with species, exhibited in this work. The genera are founded on the form of the spores, a system advocated by Kœrber, Nylander, Hepp, and others. I do not feel myself competent to decide how far it is likely to stand the test of experience.

The following remarks of the Rev. C. Babington seem to me very judicious:—"It is perhaps presumptuous to offer an opinion on a subject with which I am not so familiar as the above mentioned authors are; but it appears clear that the employment of microscopic characters must be very cautiously introduced. It is certain that the forms of these organs (the spores) vary considerably in the same species, even in the same specimen, as any one may convince himself by a little experience."—*Fl. New Zealand*. Part II. p. 268.

COLLEMACEÆ, *Nyl.*

Ephebe pubescens, *Fries.*

On damp rocks, Loch Leane,

and below Cromaglan; fruit rare.

Ephebe byssoides, *nov. sp.*

Collema furvum, *Ach.*

* Some of the rarer species are published in Rabenhorst's *Hepaticæ Europ. Excis. Decas. xxi.-xxii.*; and *Bryotheca Europæa, fasc. xi.* Dresden, 1862.

Collema pulposum, Bernh.
Synechoblastus flaccidus, Kbr.
 (*Collema flaccidum*, Ach.)
S. aggregatus, (Ach.) Mudd.
 (*Col. fasciculare* var. *aggregatum*, Ach.)
Leptogium lacerum, Kbr.
L. Schraderi, Nyl.

LICHENACEÆ, Nyl.

I. *Gymnocarpi*.

Cladonia alpicornis, Fries.
C. gracilis α. *cervicornis*, Mudd.
 (*C. cervicornis*, Schaer.)
C. squamosa, Hoff., et
 α. *cæspititia*, Mudd. (*Lichen cæspititius*, Eng. Bot. t. 1796.)
C. furcata, Huds.
 β. *racemosa*, α. *erecta*, Mudd.
C. rangiferina, β. *sylvatica*, L.
C. coccifera.
 γ. *Flörkeana*, Fries.
Beamyces roseus, Pers.
Stereocaulon paschale, L.
 β. *corallinum*, Laur.
Ramalina pollinaria, Ach.
Nephroma lævigatum, Ach.
 (*N. resupinata*, Hook.)
Sticta pulmonacea, Ach.
scrobiculata, Scop.
fuliginosa, Dicks.
limbata, Sm.
elegans, Deak.
herbacea, Huds.
Parmelia perlata, L.
saxatilis, β. *leucochroa*, Wallr.
sinuosa, Sm.
encausta, Sm.?
caperata, Dil.
Borreria cæsia, Hoff.
aquila, (Ach.) Mudd.
Physcia candelaria, Nyl.
Pannaria plumbea (Lightf.), Massol.
 (*Parmelia plumbea*, Fries.)
 This fine species, and the following, are very abundant on trees about Mucross.
Pannaria rubiginosa, Thunb.
brunnea, Sw.
 (*Lecanora pezizoides*, Bor.)
 Found on Cromaglan and the loftier mountains.

Lecanora atra, Huds.
pallescens, β. *tumidula* Pers.
Gyalecta cupularis, Ehrh.
Lecidea scapanaria, nov. sp.
Biatorina grossa, Pers.
 (*Lecidea leucoplaca*, Leight. Ex. 125).
Bacidea luteola, Ach.
muscorum (Sw.), Mudd.
 Sandhills, Malahide. The only species not collected about Killarney.
Bacidea atro-grisea, Delise.
Opegrapha rupestris, Pers.
varia α. *tigrina*, Ach.
atra, Pers.
 α. *denigrata*, Ach., et
 c. *nigrita*, Light.
vulgata, Ach.
Stenographa anguina α *divaricata*, Mudd.
 (*Graphis scripta* Leight. Ex. 19.)
Graphis serpentina var. *flexuosa*, Leight.
Aulacographa elegans (Sm.), Leight.
Stigmatidium crassum, Dub.
 (*Sagedia aggregata*, Fries.)
Arthonia ilicina, Tayl.

II. *Angiocarpi*.

Sphærophoron coralloides, Pers.
Endocarpon miniatum, L.
 β. *complicatum*, Sw.
Normandina jungermanniæ, Del.
 This species is very common on patches of *Frullania tamarisci*, &c., about Killarney, but only few apothecia were found.
Pertusaria communis, DC.
fallax, Pers.
Verrucaria chlorotica, Ach.
rupestris, Schrad.
calciseda, DC.
Thelidium immersum, Mudd.
gemmatum, Mudd.
Pyrenula nitida, Ach.
Arthopyrenia nitescens (Salw.), Mudd.
epidermidis, Ach.,
 β. *analepta*.
 α. *punctiformis*, Mudd.

4. *Letter from Dr John Kirk (of the Livingstone Expedition), dated H.M. Ship Pioneer, River Shire, East Africa, 14th December 1861. Communicated by Professor BALFOUR.*

MY DEAR DR BALFOUR,—During the last two years we have been moving over a considerable geographical area, and getting news of all your doings at home only very seldom. Our mails are most uncertain, and some get lost in crossing the bar. Unluckily there have been lives lost there also, so that we think little of letters. Africa will soon be opened up. Vast things have been done by Burton and Speke; the West, too, has been entered at one point by De Chaillu. I hoped to have heard long ago of my plants having reached England, but I fear most of them have been lost. What portion has reached I am not yet certain, but from the absence of many genera in the catalogue of what reached, I see that those collected in Zomba at high elevations have not been among the fortunate ones.

You have heard, I dare say, long ago of our journey to the Makololo country. By the time we reached it, the small remnant of the mission had gone off south; they had lost more than half their number through fever. At home they are laughing at the mixture we make of quinine and calomel; but yet we have spent four years out here and never lost a case, and during the past year we have had a large body of Europeans exposed to the fever, and frequently attacked by it, but as yet the treatment has proved successful. The *preventative* action of quinine is *boak* in our experience, and we have tried it fairly. We are to make the attempt again. In the vessel we have always had several sick at one time; so, if the quinine changes this state of matters we shall believe in it. We did try it about seven months ago, with no perceptible result one way or another.*

In the interior we found the Makololo tribes fast on the decline. The chief Sekeletu had been seized with leprosy, and, believing himself bewitched, had killed some of the old men, his father's best soldiers. Now he is dependent on the young, and they—educated among the subject tribes, and feeling their weakness, being few, among so many—have degenerated into a very different race from their fathers who took the country. Now, the subject tribes are better than Makololo; but, with the Makololo, the subject tribes about them have gone down in the scale of honour too. The contrast was marked on leaving the free people of the Batoka lands, and entering that of the Makololo. In the former we had to purchase nothing; they gave the best willingly. The Batoka lands are the only ones suited for Europeans between the coast and the interior along the Zambezi. There are many places where people eager to make money might risk themselves, but this is the only European climate, and here the thermometer sometimes falls to 32°. Sheep would succeed admirably, but for the interior there will be some time needed. The Zambezi is not navigable much above Tette, and even to that place ships only of the most limited size could ply throughout the year. Above the Kebrabasca rapids the Zambezi is again navigable, but there are rapids, and a small trade would never pay. When trade, however, does get into this region, there are immense fields of coal ready to be taken from the mountain side, and to be tumbled on board the vessels.

* [Dr Livingstone gives the following prescription:—Six or eight grains of resin of jalap, and the same amount of rhubarb, with four grains of calomel, and four of quinine, made into pills with spirit of cardamoms. The whole is a full dose for a man. On taking effect, quinine (not the unbleached kind), in four-grain or larger doses, is given every two hours or so till the ears ring or deafness ensues. This last is an essential part of the cure.]

Our return was in canoes, and by them we got over a vast extent in a short time. We had Bashubea canoe-men, and they managed these logs of wood most admirably. We came down many rapids such as I had no idea could be passed at all. The skill displayed by these men was surprising. My crew were the best, and delighted in going first. We, however, got upset in Kebrabasca, while trying to be ready to help Dr Livingstone. It was quite astonishing how we got out of this fierce rapid with perpendicular rocks all about. The canoe-men behaved well; but all my gear was lost, notes, &c., including a Government box chronometer worth L.60. In all, upwards of L.100 worth went down, and we were lucky in saving ourselves. We have been since then round to the Roruma, but this ship requiring between five and six feet when full of cargo, prevented us from getting up beyond thirty miles.

The Roruma Bay is magnificent, and the river has no bar, and has great advantage over the Zambezi, where there is a bad anchorage, and a nasty surf. But whether the Roruma comes from the lake we have not found out, although we have been at the trouble of going to see, and carrying a boat over the forty miles of the Shire which is obstructed by rapids. We spent upwards of a month on Lake Nyassa, and sailed 200 miles north on this huge inland sea; then we heard of its north end, but hunger (for the country there had been desolated) forced us to return; and, indeed, we were quite done up, for we had been robbed twice, and lost our clothing. Don't suppose they did this by force—they came at night. If they had come by day we could have settled them. The exposure on the lake in an open boat to the full effect of the sun at the hottest season was most trying, while the daily storms rendered our progress slow. On Lake Nyassa severe storms come on suddenly, and lash the shore with a surf through which no boat can pass. Indeed, a vessel to sail at all times must be one fit for the ocean. The width of the lake varies from fifteen to fifty miles, but we could not cross it on account of the storms. The waters are deep enough for all practical purposes. We got 100 fathoms at the mouth of a bay, and at one mile off shore no bottom with 690 feet of line; so, where the bottom is to be found in the centre, I cannot tell—perhaps it is below the sea level. The botany of the lake has nothing of interest until you get beyond Lat. 12°; then the trees change considerably, and the hills come down near the lake. From the rich green on these hillsides the country must be better watered than that to the south, for we were there during the driest time of the year. The people are Marimba on the west side, but the north-west is occupied by a tribe of Zulus, who had migrated from the country south of the Zambezi, and fought their way north, having established themselves with their cattle on fine table lands, described as healthy, and seemingly quite like those of the Batoka up the Zambezi. The borders of this land are deserts, all the people having been killed; and it has been a dreadful slaughter, for the shores are covered with skulls, and where a foraging party has passed, fresh bodies beginning to decompose lie scattered on the sand. Marimba are a treacherous, cowardly race, and cannot face the fierce charge of the Kaffir, who comes to close quarters at once, and defends his body with the ample shield, while he uses the club or spear with his right hand. The language of these Zulus is that of their native country, but they mix with it some words of the Lake tribes. They kill all they find except young children, and these they carry off to educate them as their own. They do not engage in the slave trade. Their only thought is the cattle; they live for them entirely, and remove from place to place according to the pasture. The slave trade is at present very active; it has received a great impulse through the so-called free colonisation of the French. The Portuguese and Arabs are the people who

take them to the coast. To the Portuguese is due the whole of that vast slave trade carried on from Ibo to Sofala. They hold that coast only to enable them to do this, while it was guaranteed them that they might put the slave trade down. Government have full knowledge of what goes on ; indeed, so must the home Government of Portugal, for they give as court favours the several governorships, which are much sought after, knowing that the salaries are perfectly inadequate. How can these men make the fortunes they do, but by countenancing the slave trade ? Already the slave agents of the Portuguese merchants of Tette have filled the Manganja hills discovered by us. They have come on our track ; and now, after being absent a year, we discovered that we had been the means of opening a slave-hunting country. The hunting was done by a coast tribe—the Ajawa. The Portuguese sent their slaves to purchase the captives. On their way, the fine rich populous valley from the south end of Lake Nyassa to the rapids of the Shire had been laid waste, and now not a village stands where, when we first passed, all sorts of food could be obtained for a few beads. We drove back the first white Portuguese who ever entered the Manganja hills. He came at the head of a large body of armed slaves, intending to save the price paid to the Ajawa, and do the hunting himself. On hearing that we were destroying all Portuguese slave bands, he turned and fled. We have made a number of captures of Portuguese agents with slaves. Those they have are chiefly children. We settle all the prizes with the Bishop ; in fact, we have made him chief of a large village, and given him such a start as no mission ever had before. Not only has he got all the slaves we took from the Portuguese, but also natives come and settle near him, for the security they feel. The Manganja country is at present in a strange state. There is no great chief, but each village is ruled by an independent man, and these seem to have sold the people for a long time back ; now they are being carried off wholesale by the Ajawa. To the latter there cannot be much blame attached. The Manganja would do the same if they were not such cowards. They cannot face the Ajawa, but they do quite as bad by assisting the Portuguese to carry off the slaves bought from Ajawa, who are many of them their countrymen, and taken from some neighbouring village. One village seems to hate another, so that they quietly allow them to be carried off. They are quite incapable of a united attack to drive the intruders out. If the Ajawa could be reclaimed they possibly might prove the better people. Dr Livingstone thought to go and speak to them, but the intentions of his party were mistaken, and they found themselves surrounded and attacked. Our party, including some of the Bishop's, had to fight in earnest, and the Ajawa did not retreat until several had been killed. We had left the vessel without any intention of fighting, and this small affair used up all the cartridges. It would be gross folly to go unarmed here—that is, without arms in the party. On Lake Nyassa, our party (over twenty men), well armed with the best of rifles and revolvers, was not numerous enough to prevent the natives robbing us twice by night, and once attempting a night attack ; and it was on the other side they killed Roscher, a Hamburg gentleman, who had reached the Lake about two months later than we did when we first discovered it in 1859. In order that the mission here (under Bishop Mackenzie) may be of use, the country must be opened up, and commerce begun ; for until the natives can sell their produce, they cannot be expected to give up the slave trade. They grow cotton, and could grow any quantity. If merchants could get in to purchase it and other things, then the natives would be able to rise in civilization ; but I don't believe in missions which are not accompanied by other means besides teaching. A mission, to be successful, must aim at raising the natives ; and the mis-

sionary's work is vastly diminished if the civilizing is in a great measure done for him by merchants and traders, and his hands thus left free for teaching. The Portuguese claim the coast, and, I daresay, the interior too; but the rivers ought to be open to all nations. At present it would be in vain to send out to purchase anything here. Being Government officers, we may do as we please; but a trader would be turned who came without a passport, and no foreign vessel would be allowed to pass.

Now, I have completely tired you out, and not said a single word about botany; and the fact is, I have done very little to it of late. We have had a great deal of work in the steam-vessel, which is two feet too deep for the river. I have had no opportunity of getting up among the hills again. My collections and notes from the Makololo country were lost when my canoe upset. On the lake we met with an oil palm with small fruit. I see it mentioned by Captain Burton on Lake Tanganyika.

I enclose some of the cotton growing uncultivated on the hills at the north end of Nyassa. It will show you the fine quality of stuff which might be obtained even now.—Yours ever, very affectionately,

(Signed) JOHN KIRK.

5. *Letter from Dr A. LEITH ADAMS to Sir WILLIAM JARDINE, Bart., relative to Poisoning with Euphorbia in Malta.*

"MALTA, 25th May 1862.

"I send you a few seeds of the sea-spurge; there are upwards of twenty species of *Euphorbia* in Malta, and during the summer months, when the intense heat has withered the plants, and pasturage becomes scanty, goats often nibble the decayed stalks of one or other species, chiefly the *E. pinea*, which is the most common. The Tenhuta is a name generally applied to all the species. The goats do not eat *Euphorbia* eagerly, and when there is plenty of green pasture not at all. The milk impregnated with this poison has, I am creditably informed, proved fatal to children under three years. Nausea, vomiting, and diarrhoea are the chief symptoms induced. The dangerous effects of milk so poisoned have been known to the natives from time immemorial; and in the country districts, when wishing to take a brisk purgative, the natives are in the habit of drinking milk to which a few drops of the white juice of the plant have been added. I am told diarrhoea is a certain result. I have been particular in attempting to find out if the goats themselves are affected, but all the herdsmen say, not apparently in the slightest degree. With reference to Dr Mackay's suggestion in explanation of the more violent symptoms in some of his patients compared with others, that the same was owing to yellow streaks in the milk and their unequal distribution, I cannot discover any proof. All the goat-herds I have caused to be questioned on the subject state that the poisoned milk does not differ in appearance from other milk, and that they have no means of knowing when milk is poisoned by *Euphorbia* until it is used. This is also the experience of Dr Gulia and other Maltese doctors. The Maltese consider the berries of the Persian lilac (*Melia Azedarach*) a deadly poison, and are careful not to let the goats eat them. Dr Gulia thinks it is a vulgar error; but many Maltese have assured me to the contrary, and that they have known persons to have been poisoned by milk of goats fed on these berries."

6. *An Account of Professor Balfour's Botanical Trip to Moffat, Dumfriesshire, on 5th July 1862. By Mr JOHN SADLER.*

7. *On the Addition of Cystopteris alpina (Desv.) to the Arctic Flora. By WILLIAM SUTHERLAND, M.A., Aberdeen.*

In my frequent examinations of the Arctic plants brought home by Mr

J. Taylor, I have always had doubts as to the propriety of consigning all his specimens of *Cystopteris* to that much-embracing species, *fragilis*. And now, after a careful examination and comparison of all the descriptions and figures, besides a few (cultivated) fronds of *C. alpina* (Desv.) within my reach, with the Arctic specimens, both dried and at present growing, I have no hesitation in stating that many of the dried, and perhaps all the living specimens, must be referred to the species indicated. Both the growing plants, and the fronds dried when gathered, were found by Mr Taylor, in Cumberland Straits, British North America.

As to the propriety, indeed necessity, of awarding *specific* honours to this *Cystopteris*, we believe there can be now no doubt. Mr Bentham, in his "Handbook of the British Flora," is the only authority we have found who has suspicions on the subject. He, however (probably from the alien character the species enjoys as British), but cursorily refers to it, and gives no characters to distinguish it from *fragilis*; while entertaining the very highest admiration and respect for the profoundly philosophic and logical character of Mr Bentham's mind, I cannot but think that had the plant been such as to call for more minute examination by him, he would have felt constrained to dismiss all doubts as to its specific claims. The case, I believe, to be far stronger than that of *Lychnis diurna*, and *L. vespertina*, where, with great judiciousness, he has recognised the probable existence of two distinct species. Sir William Hooker, in his "British Ferns," just published, considers this species as undoubtedly nearly allied to *fragilis*; but I think, truly distinct, in the more deeply pinnatifid, and more finely cut pinnules, the segments being oblong-linear, or cuniate entire, obtusely toothed. Mr Francis, an excellent authority, and the pioneer of the vast array of pteridologists who have recently, to a degree unprecedented in any other department of science, inundated the British market with their wares, speaks in equally strong terms:—"These marks clearly indicate this to be a distinct species, far removed from both the others, and in cultivation, instead of approaching the *fragilis* or *dentata*, it becomes yet more different, as the pinnules increase in length, but scarcely in width, as in the former cases."

Cystopteris alpina (Desv.), then, is a very elegant little fern, with fronds seldom exceeding six inches in height, herbaceous, and of a bright green colour, oblong-lanceolate, tripinnate, but often only subtripinnate, and erect in growth (*fragilis* not unfrequently reaches a foot in height, and then especially has a drooping, not an erect habit). The rhizome branches dichotomously, the one branch growing to the side and then throwing up a tuft of stipites, the other pushing onwards to continue this process; a much greater interval also exists between the points of divarication than in *fragilis*, which, as seen in pot cultivation, sends up its fronds more in a mass than *alpina*, where they run in more scattered groups; it is black, fibrous, and scaly towards the apex. Stipes slender, scaly towards the base, one-third the length of the frond, often less, and altogether shorter, less brittle and juicy than in *fragilis*; rachis compresso-alate. While the majority of fronds are quite smooth, I have noticed one or two having a few very small scattered scales along with stipes and rachis, an observation which does not seem to clash with one of Sprengel's characters, *fronde tenerâ, glabriusculâ*. Pinnæ, about ten pairs, with a tendency to alternation rather than otherwise, except the first pair, which is opposite, not so markedly ovate as the pinnules, i.e., slightly acute (though not always so), their midrib winged, so much so in some forms as to produce complete coalescence of all the pinnules but the first pair. Pinnules "ovate, obtuse, deeply pinnatifid, oblong or linear-cuneate, very obtusely bi-trifid, rarely entire" (Hooker). Venation straight, and corresponding to the divisions and toothings of the

pinnales (not more or less tortuous as in *fragilis* and its forms). *Sori* small, circular, mesial, scattered, pale, not crowded, and perhaps never confluent as in other species. I have not as yet satisfied myself that there is really any constant character whereby its *indusium* may be distinguished from that of *fragilis*, while authorities seem to differ on the point.*

While the plant is of easy cultivation, it is said to suffer more from the accumulation of moisture about its roots than does *fragilis*, a circumstance quite credible, from its favourite stations on the Continent being high alpine rocks, where, indeed, it would seem to be by no means very rare. Mr Foster was the first to notice the plant as British in Symon's "Synopsis," 1793. No doubt can be entertained as to the genuineness of the Low Leyton (Essex) plants, where it was said to grow *apparently* wild, and that, too, in a part of Britain very little above the sea-level. The reconciliation of this fact, with its occurring nowhere on the Continent but at elevations of from 6000 to 8000 feet (the equivalent of the new arctic station), must, we fear, always remain a botanical enigma. Mr Moore, excluding cases where *fragilis* has been mistaken for it, considers that he has received fronds of the true plant from Derbyshire and Yorkshire, as also from the Lake District. It is somewhat curious to note that Sprengel in 1827 gives "Anglia" alone as the geographical range of this plant, not apparently having recognised it on the Continent. The otherwise recorded stations are, the Alps, the Pyrenees; in Greece, Mount Taygetes (Bory, Heldreich), and Taurus (Kotschy); to which list we have now to add Cumberland Straits, British North America, in Dr J. Hooker's "Province of Arctic E. America" (excluding Greenland). *C. fragilis* is found in all his five arctic provinces except the Asiatic. I have but one specimen from Greenland, collected at Disco by the late Dr Mellis of Alexandria, and it I must certainly refer to this species. It does not, of course, follow from this, or its not having been hitherto recorded, that *alpina* does not occur in Greenland; on the contrary, it is quite possible that it may do so, as also in Scandinavia, &c. But it must be confessed, that so scanty is the information (from its being easily overlooked), that it would be rather premature to discuss the history of its distribution, which may be as wide as that of *fragilis*, which in his laborious and most able essay "On the Distribution of Arctic Plants," Dr J. Hooker has shown to be very extended. In the meantime, therefore, it must be placed in the somewhat small list of plants common to Arctic America and the Alps of Europe, but not occurring in Arctic Europe, thus extending from Arctic America through Central Asia and Northern India to Central Europe, a supposition to which the Grecian stations lend some support.

A letter was read from Mr J. Chalmers Morton, editor of the "Agricultural Gazette," in which he expressed a wish to know the predominating plants growing on the irrigated meadows at Craigenlinny. Professor Balfour had sent Mr John Scott, one of the gardeners in the Botanic Garden, to make a collection of the plants, of which the following is a list:—*Stellaria media*, *Poa trivialis*, *Ranunculus repens*, *Rumex obtusifolius*, *Senecio vulgaris*, *Polygonum amphibium*, *Cardamine pratensis*, *Atriplex patula*, *Ranunculus sceleratus*, *Alopecurus geniculatus*, *Glyceria fluitans*, all of which were growing very rank and luxuriant, forming almost the entire pasturage. On the sides of the ditches occurred *Ranunculus acris*, sparingly, *Anthriscus sylvestris*, *Holcus lanatus*, *Galium aparine*, *Triticum repens*, *Leontodon Taraxacum*; and in drier

* I may here mention that Mr Sim gives a form called *intermedia* (of which a frond is before me). It really seems judiciously named, for it certainly combines both the characters of *fragilis* and *alpina*.

spots *Potentilla anserina*, *Trifolium repens*, *Plantago lanceolata*, *Alopecurus pratensis*, *Lolium perenne*, *Phleum pratense*, *Dactylis glomerata*, *Hordeum murinum*, *Arrhenatherum avenaceum*, *Geranium dissectum*, *Cerastium triviale*, and *Bellis perennis*.

SCIENTIFIC INTELLIGENCE.

BOTANY.

Number of Seeds Produced by Orchids.—Darwin estimated the seeds contained in four capsules of *Cephalanthera grandiflora* at 24,000, and in thirty capsules on a plant of *Orchis maculata* at 186,300. An acre of land would hold 174,240 plants of *Orchis maculata*, each having a space of six inches square, which is rather closer than they would flourish together; so that allowing 12,000 bad seeds, an acre would be thickly clothed by the progeny of a single plant. At the same rate of increase, the grandchildren would cover a space slightly exceeding the Island of Anglesea; and the great-grandchildren of a single plant would nearly (in the proportion of 47 to 50) clothe with one uniform green carpet the entire surface of the land throughout the globe.—*Darwin on Orchids.*

Hybrid Plants Returning to their Original Species.—In 1854, M. Naudin fertilised *Datura Tatula* and *Datura Stramonium* with each other, and obtained hybrids (*Comptes Rendus*, 1856, 1st semestre, p. 1007). In 1861, he repeated the experiments, with the view of carrying out the results more fully. Seeds preserved from the first crossing in 1854 were sown in the month of April 1861. He thus obtained the hybrid *Datura Stramonio-Tatula* of the first generation, which reproduced all the characters which had been observed by him six years previously, namely, the size double that of the parents, the flower of the first seven or eight dichotomous divisions falling so that the flowering was retarded, and a colouring of all the parts of the plant perfectly intermediate between that of the two parents, which are in that respect very marked,—the one, *D. Stramonium*, having the stem and branches of a bright green, and the flowers all white,—the other, *D. Tatula*, having the stem and branches purplish-black, and the flowers violet. In consequence of the flowering being late (towards the end of September), when the plants belonging to the pure races of *D. Stramonium* and *D. Tatula* had long finished flowering, and had even ripened their seeds, the hybrids were placed in an isolated condition, so that they could only be fertilised by themselves. In consequence of the advanced state of the season, a few of the capsules in the hybrids only arrived at a semi-maturity; but these contained seeds in a condition to germinate. These seeds, sown in April 1862, produced twenty-two plants of the second generation, the greater part very different from those of the first. They divided themselves in the following manner: 1. Five individuals reproduced *Datura Stramonium* in all its purity, with the stems and branches of a clear-green, and the flowers all white. They also regained the size and the precocious fecundity of the species, flowering and fruiting at the first dichotomous division. The fruits ripened, and the seeds came to maturity. 2. Nine individuals, with purplish-black stems and branches and violet flowers, reproduced perfectly the typical *Datura Tatula*. They also flowered and fruited at their first dichotomous division. The seeds were being ripened. The plants did not in any respect resemble *D. Stramonium* (their grandfather). 3. Two other individuals flowered and fruited in the same way, and exhi-

bited the normal size of *D. Tatula* ; but the stems and branches in them were of a less deep purple, and the flowers of a paler violet colour than in the typical species. These two specimens were different from the hybrids of the first generation, but they did not return completely to the type. They still showed marks of hybridity. 4. Finally, six individuals approached decidedly nearer to *D. Tatula* than did the hybrid of the first generation, but they still showed a relation to that hybrid in their size being larger than that of the parents, and by the fall of the flowers on the first dichotomous branchings. It is clear, however, that the flowering is not far distant, and that it will be more abundant than that of the hybrid which produced them. It is probable that the posterity of the third generation will return completely to *D. Tatula*.

Many other examples of a similar kind might be given. All, without exception, demonstrate the fact of the spontaneous disappearance of fertile hybrids, without the intervention of a crossing with one or other of the parent species. This return of hybrids to their productive types appears to Naudin inexplicable at present, but he means to take up the subject at a future time.—*Comptes Rendus*, Août 18, 1862, p. 321.

Marine Algae found on the Buoys in the Firth of Clyde, from Port-Glasgow to the Cumbræ and Garrochhead.

Upon eight buoys.
Laminaria saccharina.
Chordaria flagelliformis.

Upon seven buoys.
Ceramium rubrum.
Enteromorpha compressa.

Upon six buoys.
Chorda lomentaria.
Ectocarpus tessellatus.
Polysiphonia urceolata.

Upon five buoys.
Desmarestia viridis.
Punctaria plantaginea.
Ulva latissima.
Linza.

Upon four buoys.
Desmarestia aculeata.
Polysiphonia elongata.
atro-rubescens.
Porphyra laciniata.

Upon three buoys.
Ectocarpus siliculosus.

Polysiphonia Brodiaei.
Rhodymenia palmata.
Conferva Youngana.

Upon two buoys.
Chorda filum.
Ectocarpus littoralis.
Chrysomenia clavellosa.
Delesseria sanguinea.
sinuosa.
Callithamnion Daviesii.
virgatulum.
Enteromorpha erecta.

Upon one buoy.
Laminaria digitata.
bulbosa.
Cutleria multifida.
Punctaria tenuissima.
Ectocarpus fasciculatus.
Hincksia.
pusillus.
Rhodomela subfusca.
Polysiphonia violacea.
nigrescens.
Cladophora lanosa.
Enteromorpha ramulosa.

Dr Grieve and Mr Robertson in Proc. of Glasg. Phil. Soc.

GEOLOGY.

Geological Survey of India.—This survey is going on with vigour, under the able superintendence of Dr Oldham. By the last Annual Report, it appears that the following districts have been surveyed more or less completely :—In Bengal, the country adjoining the Kurruckpore Hills in Monghyr, and extending across the district of Behar, so far on the parallel of Gya ; also the coal-fields in the south, from the limits of

the Burdwan district to the Ghats at Dhurwa, and southward to Hazaribagh; in Central India, the Rewah district, in the southern part of which coal exists; in the north-western provinces, the Sewalek and sub-Himalayan rocks of and near Kangra; in Madras, the districts of Cuddapah and Kurnool; in Pegu and Tenasserim, the district of Henzada, which contains some petroleum wells. The publication of the Memoirs of the Geological Survey, with excellent palæontological plates, is an important step in geology. This valuable work reflects the highest credit on Dr Oldham and the officers of the Survey, and bids fair to develop the mineral treasures of our Indian possessions. The formation of a geological museum and library is also a subject of congratulation.

Summary Statement of the Amount of Coal Raised throughout India for the years 1858-59-60. By T. OLDHAM, LL.D.—In publishing the following summary of the amount of coal raised throughout India during the above-mentioned years, it must be premised that the term *year*, here used, does not exactly coincide with the ordinary year, but refers to the season or time from the commencement of the working season, in November or December, to the close of the same season, in May or June following, for all open works or quarries, and from the same time to the following November for all pit-work. In the Ranigunj field, the only mode of transport originally was by the river Damuda, a stream only navigable during the freshes of the rainy season; and hence arose the custom of closing the year's account in that district, when, after the passing away of the rains, the river became so dry that no more could be sent to market. The end of September or of October thus became the acknowledged end of the year for accounts. The statements here given are therefore up to the 30th of October in each year:—

NAME OF FIELD.	COAL RAISED.					
	1858.		1859.		1860.	
	Maunds.	Tons.	Maunds.	Tons.	Maunds.	Tons.
Ranigunj.....	5,917,000	217,136	8,949,600	324,754	8,559,097	304,094
Kurhurbari.....	4,000	147	108,182	...	275,256	...
Palamow.....	...	...	28,648	...	30,900	...
Rajmahal Hills	92,000	...	90,000	...	101,860	...
Brahmini Nuddi and neighbourhood.....						
Bansloi Nuddi.....						
Goomani.....	27,000	...	97,000	...	81,000	...
North-west of Hills Borah, Hurra, &c.....	100,000	...	150,000	...	340,000	...
Silhet Hills.....	...	...	506,000	...	700,000	...
	22,319	...	32,498	...	...	...
	6,162,319	226,140	9,461,928	347,227	10,088,113	370,206

For the Singrowli field, in the south of Rewah, I have not been able to procure any return; but the amount raised has not been large. In the Nerbudda district no coal has, I believe, been yet brought to market;

but the Nerbudda Coal and Iron Company have this year commenced their operations. In the Punjab no coal is raised, the small and irregular patches of lignite which occur in the Salt Range and elsewhere yielding only a few maunds of fuel in the year. In Oude—none; in Madras—none; in Bombay—none. In Sindh, in the Lynah Valley, a quantity amounting to 45,300 maunds was raised in 1858-59; but this could scarcely be called a colliery, and the works were soon abandoned.

The total amount of coal raised in India generally (indeed it may be said in Bengal), has increased from 226,140 tons in 1858, to 347,227 in 1859, and to 370,206 in 1860.

ZOOLOGY.

Bombyx Cynthia or *Ailanthus Silkworm*.—This silkworm was first introduced from China in 1856 by Fantoni, a Piedmontese, who sent a few living cocoons to some friends in Turin. The moths emerged from their cocoons in June 1857, and laid eggs which were hatched in a few days. The worms were fed on the leaves of *Ailanthus glandulosa*, a plant belonging to the natural order *Simarubaceæ*. In 1858, the silkworm was established in Europe, and it has since been reared extensively in France, and partially in Britain. It is said that in France more than 2000 amateurs are now engaged in rearing this worm. Mr Howgate, in the "Social Science Review," makes the following remarks on this subject: "The eggs of the *Ailanthus Silkworm* are not preserved through the winter like those of the Mulberry Silkworm, but are hatched a few days after being laid, and the worms attain to maturity so rapidly that in China and Algeria three generations are produced in the course of one summer; even in our colder latitudes two crops of cocoons can be gathered each year, the moths of all the second and part of the first gathering remaining inside the cocoons until the following spring. After emerging from the egg, which is twice as large as that of the Mulberry Silkworm, the caterpillar of the *Bombyx cynthia* passes through five stages of existence before forming its cocoon, at which time it is about two and a-half to three inches long. In the first stage it is yellow with black spots down the belly. After this it passes from yellow to white, and from white to green. The cocoons, as we have said before, differ from those of the ordinary silkworm in having an elastic opening at one end. This opening is not made by the thread being cut, as some have supposed, but by its being turned back at a very acute angle. The colour of the cocoons is a pale grey, and they are from one and a-half to one and three-quarter inches long, and about three-quarters of an inch broad. The butterfly of the *Ailanthus Silkworm* is much larger and more beautiful than that of the ordinary silkworm; the head is of a greyish brown, the wings of a light brown colour strongly tinted with grey, with a bar rising near the middle of the anterior edges of the superior wings, and continued along the inferior wings, forming an equilateral triangle, the outer part of which is ash-coloured, and the inner part light brown. At the top of each of the superior wings is a small eye, the lower part of which is black and the upper part white, whence a faint white line runs to the extremity of the wing. A small narrow black line runs along the external edge of all the wings. There is also another ash-coloured bar on the superior wings, and an ash-coloured crescent verged with black on the middle of the inferior wings; another crescent, larger and much fainter, appears a little higher up. The extreme facility with which the *Ailanthus glandulosa*, the tree which furnishes food to this new species of silkworm, can be cultivated, seems to render the introduction of this new branch of industry into England a matter of very little difficulty." Another kind of silkworm in China feeds on the *Ricinus communis* or castor-oil plant, but

it does not suit the climate of France. The culture of this insect has been successful in the Canaries.

As great disease has recently occurred among the silkworms in France, it became important to introduce a new species. The silk culture in France alone yields 300,000,000 francs per annum. The silkworm ordinarily produces about 150,000,000 francs of raw silk, besides which about 60,000,000 francs value have been imported. The silk, after being manufactured at Lyons, Nîmes, St Etienne, &c., acquires a value of more than 310,000,000 of francs. The disease of the silkworm becomes, therefore, to these manufacturing centres, a perfect scourge. The Society of Acclimation in France endeavoured to examine into the cause of the disease among the silkworms. It appears that the disease is caused principally by a diseased state of the mulberry trees, on the leaves of which the silkworms are fed. The insect disease was cured by placing the infected eggs for some time in a box containing a little spirits of turpentine. This treatment, however, does not prevent the reappearance of the disease in the worms when they are fed upon the leaves of the diseased mulberry trees.

MISCELLANEOUS.

Observations upon Photographic Pictures. By J. ALEXANDER DAVIES. —I would observe that in photographic pictures we may at once perceive the comparative luminosity of any colour, the several colours of any object or objects being represented by shades of black, which are lighter in proportion to their *luminosity*, or, which is the same thing, their resemblance to *white*, and *not* according to their *intensity*, or, in other words, degree of shade. This distinction is one of great importance, and has not, as far as I am aware, before been noticed.

Many, undoubtedly, have observed that all single and stereoscopic photographic landscapes, involving great distances, are in one way unnatural—which is, that the distant parts appear too near, and that this imperfection is actually greater in proportion to the perfection of the work; but the cause of this has not, I think, been pointed out, neither, in my knowledge, has the fact been recorded. I say, therefore, that it arises from the circumstance that we judge of the distance of any object by the *intensity*, and not the *luminosity* of its colour, on which account it is in every case possible to estimate distances in good paintings, where, the colours being given, their intensities may, of course, at once comparatively be seen; and would also mention that the magnificent photographs of Alpine landscapes are illustrations of the imperfection in question—an imperfection which it is not possible to deny, unless the spectator endeavours to imagine the *proper* distances between him and the several distant objects when they are imagined *properly* to represent these distances. I doubt not that the necessary imagination is generally put forward, and hence, that by the majority of individuals the imperfection is not perceived; and would further remark, that this faculty is of great importance in every phenomenon of vision, the mind being the ultimate instrument of all our visual knowledge, and should therefore very carefully be watched. Thus, the act of endeavouring to imagine that any painting is a model, certainly *somewhat* impresses us with the idea of the solidity of the various objects represented; we then have them appear more or less protuberant. And inasmuch as the stereoscope only effects solidity, that is, by throwing the pictures into the same space, by which effect this idea is produced, the idea of distance, even in this case, being a *mental* result, it may be affirmed that the above reasoning can be applied to its use. The distant parts of well-executed photographs appear nearer than do those of inferior ones, and this because

the minuter delineation of every object makes us the more reject the idea of the distance intended.

Aluminium.—M. Garapon, an artisan of Paris, has solved the problem of drawing aluminium into wires. He furnishes the wire from 60 to 100 per cent. cheaper than silver wire of the same length. The price of aluminium is about 200 francs per kilogramme. For the purpose of drawing into wire they commence with rods of one metre in length and 12 millimetres diameter; this the inventor easily reduces to wires of the size of a hair, and many hundred kilometres in length.

Table of Heights of some of the Principal Peaks in the World.

A. IN INDIA.

1. Nilgiris.

Name.	Feet.
Doddabétta	8,640
Bevoibétta	8,488
Makúrti	8,402
Daversolabétta	8,380
Kúnda	8,353

Name.	Feet.
Kundamóya	7,816
Tamberbétta	7,292
Kokalbétta	7,267
Urbétta	6,916
Daverbétta	6,571

2. Ceylon.

Name.	Feet.
Péduru tálla gálle	8,305
Kirigalpótta	7,810
Totapé la	7,720
Samanála, or Adam's Peak	7,385
Namúna Kuli	6,760

3. Central India.

Parisnáth	4,469
Abu	3,850
Rajmírgárh	3,753
Bábul	3,354

4. Dékhan.

Kalsubái	5,410
Dhórup	4,745
Varáda	4,655
Tórna	4,619

Pútta	4,569
Ikhára	4,482
Aunda	4,339
Mándvi	4,123

B. IN THE HIMALAYA.

Gaurisánkar	29,002
Kanchinjínga	28,156
Síhshur	27,799
Dhavalagíri	26,826

Yássa	26,680
Jibjibia	26,306
Barathór	26,069
Yángma	26,000

Nánda Dévi	25,749
Ibi Gamin	25,550
Naráyani	25,456
Jánnu	25,304

C. IN THE KARAKORUM.

Dápsang	28,278
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Díamer	26,629
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Masheribrúm	25,626
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D. IN THE KUENLUEN.

The peaks seem not to exceed 22,000 feet.

E. IN THE ANDES.

Authorities: H = Humboldt; K = Kellet and Wood; P = Pentland.

Aconcagua	23,004 K
Sahama	22,350 P
Parinacota	22,030 P

Gualateiri	21,960 P
Pomarape	21,700 P
Chimborazo	21,422 H

Sorata or An- cohuma	21,286 P
Illimani	21,145 P

F. IN THE ALPS.

Mont Blanc	15,784
Monte Rosa	15,223
Täschhorn, or Lagerhorn	14,954

Weisshorn	14,813
Mont Cervin*	14,787
Dent Blanche*	14,305

Grand Combin*	14,134
Strahlhorn	14,100†
Finsteraarhorn	14,039

American Journal of Science and Arts, July 1862.

* The heights are taken from p. 511 of "Peaks, Passes, and Glaciers," edited by J. Ball; London, 1859. The others, for which no modification is known since 1854, are from Schlagintweit's "Phys. Geographie der Alpen."

Table of the Principal Mountain Passes.

A. IN INDIA.

1. Dékhan.

Name.	Feet.	Name.	Feet.
Bapdéo.....	3,499	Pocháma.....	2,446
Katrúj.....	3,019	Nána.....	2,429
Par.....	2,698	Jām.....	2,328
Nagchérri.....	2,645	Málsej.....	2,062
Návi.....	2,617	Tal.....	1,912
Sápi.....	2,478	Bhōr.....	1,798

2. Málva.

Name.	Feet.
Péndera.....	3,498
Silva.....	1,928
Mándla.....	1,626
Póppera.....	1,560
Gúmba.....	1,553
Singrámpur.....	1,437

3. Karnátik, Nilgiris, and Ceylon.

Sigur.....	7,204	Rangbódde.....	6,589	Gantvarpílli.....	2,373
Sispára.....	6,742	Kodúr.....	2,401	Kistnaghérri.....	2,150

B. IN THE CREST OF THE HIMALAYA.

From Sikkim to Kíshitvaár.

Ibi Gamin.....	20,459	Umási.....	18,123	Kiungar.....	17,331
Dónkia.....	18,488	Lángpia.....	17,750	Níti.....	16,814
Jánti.....	18,529	Máyang.....	17,700	Vallanchún.....	16,756
Párang.....	18,506	Lípu.....	17,670	Púling.....	16,726
Mána.....	18,400	Uta Dhúra.....	17,627	Shinku La.....	16,684
Nélong.....	18,312	Birmkánta.....	17,615	Bára Lácha.....	16,186
Kióbrang.....	18,313				

C. IN THE CREST OF THE KARAKORUM.

From long. E. Gr. 76° to 79° 30'.

Mustágh.....	19,019	Changchénmo.....	18,800	Karakorúm.....	18,345
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D. IN THE CREST OF THE KUENLUEN.

From long. E. Gr. 78° to 80°.

Elchi.....	17,379	Yurungkásh.....	16,620
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E. IN THE ANDES.

Alto de Toledo.....	15,590	Langunillas.....	15,590	Assuay.....	15,526
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F. IN THE ALPS.

St Théodule.....	11,001	New Weissthor.....	12,136	Old Weissthor.....	11,871
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American Journal of Science and Arts, July 1862.

Heights of Lakes of Western Tibet, Turkistan.

	Feet.		Feet.
Aksáe Chin	16,620	Nima Kar	15,100
Tso Gyagár	15,693	Hánle	14,600
Tso Kar, or Kháuri Taluá	15,684	Tso Gam	14,580
Múre Tso	15,517	Tso Rul	14,400
Kiúk Kiol	15,460	Tso Mitbál	14,167
Mansaráur, or Tso Mápan	15,250	Upper Tsomognalari	14,050
Rákus Tal, or Tso Lánag	15,250	Lower Tsomognalari	14,010
Tsomoriri	15,130		

American Journal of Science and Arts, July 1862.

On Norfolk Island, its Character and Productions. By CHARLES TOOGOOD DOWNING, Esq., M.D.—Norfolk Island, discovered by Captain

Cook in 1774, is a small spot of land in the Pacific Ocean, south latitude $29^{\circ} 2'$, east longitude $168^{\circ} 1'$. From the capital of Tasmania, of which it is a dependency, it is 1200 miles distant, and about 900 from the port of Sydney. With it are associated Phillip and Nepean Islands on the southern side, and the Bird Islands, or Rocks, seven or eight in number, on the northern shore. The variation of the needle is $11^{\circ} 00$ E.

The group is isolated, not only from its distant position, but its inaccessibility. There is no secure harbour, and the surf beats so heavily on the coral reefs and igneous rocks with which the coast is guarded, that often for weeks together no landing can be effected. A moderate depth of water extends some miles from the shore, the bottom consisting of banks of coral sand mixed with shell, and affording, although exposed, anchorage; but nearer in, and especially between the islands, the ground is hard and rocky, rendering the holding insecure, and fouling frequent. The insecurity from this source is much increased by the force of the current, which often runs at the rate of $2\frac{1}{2}$ or 3 knots an hour between the islands.

The general tides are regular and usually equal, flowing by the shore six hours each way. They make, however, two hours sooner on the Norfolk Island coast than in the stream, or over towards Phillip Island. The flood runs to the S.W. by S., the ebb to the N.E. by N. The rise is from 5 to 7 feet, and the flow, at full and change, $7\frac{1}{2}$ hours. Commonly speaking, the tides on this coast will carry a ship clear of danger, not into it. The only exceptions are with respect to the Bambora Rocks at the S.W. extremity of Norfolk Island, and a low point almost corresponding to them, projecting from the S.W. point of Nepean Island. On both these the tides set almost directly, and as they are respectively at the east and west extremities of the bay in which the settlement is placed, and not more than three miles and a half apart, they add much to the danger. On these Bambora Rocks the *Sirius* was wrecked from this cause in 1791.

Norfolk Island, of an irregular quadrangular form, is about seven miles in length from east to west, by four in breadth from north to south. From the survey taken by Major Burney, the commanding Royal Engineer of New South Wales, in 1840, we learn that the superficial extent of the island is 8960 acres; of this, 1080 acres were then cleared for agriculture, and about 1000 were pasturage. The relative proportions of these have since varied, and rather more land has been brought into cultivation.

The average height of the island is from 300 to 400 feet above the level of the surrounding ocean, although the land is generally higher on the northern side. In this direction lofty perpendicular cliffs bound the shore, and Mount Pitt, with its double summit, rises to an elevation of 1050 feet above the level of the sea. From hence the surface has a gradual declension towards the south, and terminates in a level flat, but little above high watermark, on which the settlement is placed. The surface is so irregular that, in the language of a sailor, if correctly laid down in a plan, with all the hills and valleys accurately represented, Norfolk Island would very much resemble the waves of the sea in a gale of wind; for it is composed wholly of long, narrow, and very steep ridges of hills with deep gullies, which are as narrow at the bottom as the hills are at the top.

The soil of the island is very uniform, consisting of a red, porous, ferruginous earth, originating in the decomposition of volcanic rocks (Wacke) of ancient date, which occur in seams of various shades of colour like true strata, and pass insensibly into basalt; of which, sometimes columnar, the cliffs on the northern shore are formed. This friable earth alternates with white concretionary marl, both studded with boul-

ders of porphyritic rock, gradually disintegrating. This is evident by their outer layers crumbling into dust under the finger, but gradually becoming denser towards the centre, where their texture is as hard and crystalline as granite. Pumice is found abundantly on the coast. In fact, the whole geological character of the island is indicative of volcanic agency. The low flat on the southern shore, previously alluded to, about a mile in extent from east to west, and a quarter broad, is alone of aqueous origin. It consists of coarse marine limestone, or calcareous grit of recent deposit, and is usually employed for building purposes, but yields, on burning, lime of great purity. Near this is also obtained sandstone, or calcareous grit of fine quality, from which dripestones and other porous vessels are manufactured.

The only metal found on the island is iron, in the mineral forms of red and yellow ochre. A chalybeate spring has been noticed at Orange Vale.

Phillip Island is about five miles distant from the settlement. It is $1\frac{1}{2}$ mile long, $\frac{2}{3}$ ths of a mile broad, the general elevation being greater than that of Norfolk Island, and averaging 800 or 900 feet above the level of the sea. In physical structure the two islands are identical, Phillip Island consisting of porphyritic rocks more or less disintegrated, and a small quantity of calcareous grit, known as the Sloop Rock, on the shore.

Nepean, situated within the former, is about 400 yards from the beach of Norfolk Island. It is a rugged, rocky islet, a quarter of a mile long, and of a horse-shoe form, open to the east. Formed entirely of marine limestone, it rises about 50 feet above the level of the sea, and serves as a habitation to birds, and to them alone.

Rocks, chiefly basaltic, which are separated from the northern coast of Norfolk Island by rapid currents, and worn into caverns by their waves, constitute the Bird Islands.

Norfolk Island is abundantly supplied with water of excellent quality. The streams are small and insignificant, but fountains rise from the rock in every direction, and collecting, run as brooklets down the valleys. The rain which falls during the year is moderate in quantity. Sometimes, as might be expected in a country so near the tropics, it falls abundantly. Yet, however heavy or long-continued the shower, no water accumulates, as the drainage is thoroughly accomplished by means of the deep gullies which radiate in all directions from the high land towards the sea. Vegetation is hence most luxuriant. Rain falls at all periods of the year, but chiefly during the winter. Fogs and mists are unknown. But few days occur in the course of the year in which the sky is not more or less clouded, and the horizon rarely presents that clear defined outline so common in the Australian Colonies. In the summer seasons the prevailing winds are generally dry and from the eastward. In the winter months they come chiefly from the opposite quarter, accompanied by clouds and showers. The few heavy gales are from the south. But the wind most dreaded is that from the north, which comes loaded with heat and moisture, and exercises a relaxing and baneful influence upon the human frame. The average duration of these winds is two or three days, and they usually occur three or four times in the month.

The temperature of the island may be considered both moderate and equable. The highest reading of the thermometer during the year 1847 was 87° Fahrenheit, the lowest 49° ; the mean annual temperature, deduced from four daily observations, including the lowest at night and the highest by day, was $68\frac{1}{2}^{\circ}$; the mean difference between the extremes of day and night 17° . In the year 1850, the highest reading of the thermometer in the shade out of doors was 85° , the lowest 51° , showing an annual range

of 34°. The mean monthly temperatures during the same year were as follow :—

January	74	July	62½
February.....	74½	September	64½
March	73	October	65
April	70	November	70½
May	65½	December	72½
June	63		

These figures indicate an extreme of mean monthly range for the year of 12½; less by 1½ than that of 1849; with an annual mean of 68°,—exactly the same as that of the previous twelve months.

The *climate* of Norfolk Island, although somewhat relaxing, is considered salubrious. The chief diseases to which residents are subject, as gathered from the medical reports of many years, result from the prevailing heat and moisture, often producing debility and relaxation of the mucous membranes. Few escape without some symptoms of this on their first arrival. Dysentery, of a type intermediate between tropical and European, is rather common, and may be attributed, in addition to the causes previously mentioned, to the inordinate use of lemons, guavas, and other wild fruit. It is in a measure endemic in the island. Ophthalmia, chiefly conjunctival, prevails almost epidemically during the months of August, September, and October, the exciting cause being atmospheric. Bronchitis again prevails during the winter months. The same may be said of the many rheumatic cases that occur, and which are almost all muscular, such as pleurodynia, lumbago, &c.; the articular form being of very rare occurrence. Such are the ordinary ailments of the place; but it is by no means free from other occasional visitations. Scarlet fever, for instance, made its appearance on the island, without apparent propagation, at the time it prevailed as an awful scourge in Tasmania.

The soil of Norfolk Island is of exuberant fertility, so that the rewards of industry may be obtained without its exertion. Forest trees grow in great abundance, and beneath them a rich growth of underwood. This appears to have been the case at the time of its discovery, for Captain Cook remarked that the ground was so thick with shrubs and plants for about two hundred yards from the shore, that there was great difficulty in penetrating further inland. This great navigator noticed the striking similarity in natural productions between this group and New Zealand. This was doubtless the case at the time he paid his visit; but since then, so many things have been introduced, so many plants have been cultivated, abandoned, or suffered to grow wild, that it is no easy matter to determine at the present day which are and which are not indigenous. It will be well perhaps to describe the nature and economical uses of the more remarkable of these productions.

The most striking objects that meet the eye on nearing the land are the lofty tops of the Norfolk Island Pine, the *Araucaria excelsa* of botanists. This, one of the most elegant of the Conifers, towers high above the surrounding forest, or takes its position singly or in clumps on the very verge of the ocean. It thus forms a characteristic feature in the landscape. In height, it may formerly have ranged from 150 to 200 feet, but of late years few trees of this latter elevation have escaped the axe. This pine, compared by some to those of Caledonia and New Zealand, resembles the Norway spruce, although the tier of its branches are more distant and regular. The timber is not of good quality, as it soon rots when exposed to the weather, and fearful ravages are made in it by the teredo or auger-worm, when exposed to its action. The bullock-fences of the island require renewal every two or three years. When employed

for building purposes, such as flooring in the interior of houses, it is more durable. The knot of this pine is compact, hard, and fine in grain, and, from its translucency and rich dark tint, is admirably adapted to hollow turnery. Beautiful specimens of this work, executed in this wood, were sent from Tasmania to the Paris Exhibition. These pine-knots, when defective, serve another very useful purpose. They make excellent fuel, and, on account of the rich hydro-carbons with which they are charged, burn with the brightness and persistence of the best English coal.

For economical purposes, the iron-wood, *Notelæa longifolia*, or *Olea apetala*, is the most important and valuable of the indigenous timber-trees of Norfolk Island. It yields a fine, close-grained wood, very hard and durable. This is chiefly employed in wheelwright's work, but may be used with advantage by the cabinetmaker, as some specimens are remarkably well veined.

Among the many ornamental woods obtained from this ocean isle should be enumerated the rosewood, believed to be a species of acacia, the beech (so called), the maple, *Acer Dobinea* (?), the hopwood, obtained from the *Dordonia orientalis*, the hard yellow-wood, from the *Blackburnia pinnata*, the white-wood, and the cherry-tree,—a species of *Exocarpus*; the bark of this latter, rich in tannin, has been used in making leather.

Pursuing our investigation of the vegetable kingdom, we come to what is locally called the White Oak, the *Hibiscus*, or *Laguncæ Patersonii*. It is perhaps the largest plant known to exist belonging to the *Malvaceæ*, or Mallow Tribe. Attaining sometimes an elevation of sixty or eighty feet, and displaying a profusion of large pink flowers with leaves of whitish green, it would form an elegant addition to the shrubbery. In an economic point of view it is valueless, except for firewood.

The Cabbage-tree, *Arcaea*, or *Seaforthia sapida*, was noticed by Cook, and has been since well described by one who visited the island. It is a handsome palm, with a trunk about twenty feet in height and from one and a half to two feet in circumference, with annular scars, left by the fallen leaves.

The *Freycinetia Baueriana*, or Norfolk Island Grass-tree, belongs to the tribe of *Pandaneæ*, or Screw Pines. Its stem, an inch and a half in diameter, and marked by rings as the former, lies on the ground, or, winding round the trunks of trees, climbs like ivy to their summit. The branches are crowned with crests of broad, sedge-like leaves. From the centre of these arise masses of red, pulpy fruit, four inches in length and as much in circumference. While in flower the centre leaves are scarlet, which adds to the splendid appearance of the plant.

In the open, grassy valleys, two or three species of tree-fern, the *Alsophila excelsa* and *Cyathea medullaris* exhibit, with *Marattia elegans*, their rich crests among the surrounding verdure. They often measure forty or fifty feet in height, and have fronds of great length and magnificence. From the centre of the trunk a black wood is extracted, and used by cabinetmakers for stringing.

The Norfolk Island Bread-fruit differs much from that grown at Tahiti or the West Indies. It is the *Charlwoodia australis*. Attaining twenty feet in height, it branches from within a few feet from the ground, and forms several heads with flag-like leaves, and long branched spikes of greenish star-flowers. These are succeeded by small purple berries, the food of parrots.

The native Spice-plant, by many thought to be the pimento, is the *Piper Pittacorum*, or *Aca* of the South Sea Islands. It yields fruit of a yellow colour and long cylindrical form, which has an aromatic taste, and may be employed as a pickle or preserve.

The Blood-tree yields on tapping a fluid of a bright red colour. This has been used as medicine as an astringent, but is more generally employed as a marking ink, as the stain on linen is indelible.

The Cotton-plant was once cultivated by Captain Maconochie with advantage. It is now wild, and overruns every part of the island to such an extent as to render the Bush almost impracticable.

The *Phormium tenax*, or New Zealand flax, has always grown abundantly on the cliffs of the northern coast, and on the steep declivities of the hills inland. It is a large, handsome plant, with sedge-like leaves. It has not lately been cultivated for economical purposes. We are assured, however, that two New Zealanders were once introduced to teach the people how to prepare it, but their process was so tedious that the scheme was abandoned.

The chief medicinal plants growing wild are the *Datura Stramonium*, *Ricinus communis*, and the *Solanum nigrum*. This latter is a fine, ornamental shrub, the berries of which, reported poisonous in England, have been cooked and eaten here with impunity.

Many climbers of great luxuriance and beauty are seen winding round the trunks of fern and forest trees, or hanging in graceful festoons from stem to stem. The slender Jasmine, *Jasminum gracilis*, at home a delicate hot-house plant, is one of the most distinguished of this group. Its twisted stems, of considerable thickness, may often be seen hanging like ropes from the lower branches of the pine, or white-oak, while its flowers cluster in the top. The rosy-pink petals of the *Ipomœa pendula*, greatly resembling those of the *Convolvulus major*, and the purple and green pea-flowers of the Wistaria, deserve especial notice. Two species of passion-flower also grow in the Bush, and attract much attention.

Whilst a convict station, upwards of 1200 acres have been brought under cultivation for agricultural purposes. The chief produce has been rye, oats, and Indian corn. The soil and climate are not adapted to the growth of wheat; several times it has been tried unsuccessfully. The crops were most uncertain, chiefly owing to rust and smut. The fungi of these diseases were speedily developed, and proved destructive by their rapid dissemination. The farm operations have always been effected by manual labour; yet that it has not been unproductive is shown by the returns for three consecutive years, obtained from the Commissariat Office. There were harvested in

1845.....	425,365 lbs. of	maize, or about	8,507 bushels.
1846.....	421,790 lbs.	ditto	8,435 bushels.
1847.....	711,296 lbs.	ditto	14,225 bushels.

There were two large gardens belonging to the Government: one at the Cascades, the other at a lovely spot called Orange Vale. In these, as well as in the private grounds of the civil and military officers, the variety and luxuriance of produce were extreme, the chief labour arising from the necessity of constant weeding. At the dinner table of some of the residents I have observed seven or eight different kinds of vegetable, obtained the same day from their gardens. It may be well to enumerate some of the things cultivated, in order to show the capabilities of the island in this respect.

The Coffee-plant thrives well, and yields berries of small size and good flavour.

The common or round potato is cultivated, but not with success, although four crops are produced yearly from the same soil. There is a great tendency to run to stalk, from rapidity of growth, and the tubers are generally small and watery.

The Sweet Potato, or *Buck*, as it is called, the large tuberous root of

the *Batatas edulis*, a plant of the *Convolvulus* tribe, is the chief garden esculent. It yields good crops twice a year, and may be eaten roasted, boiled, or fried in slices.

The Arrow-root is very extensively and successfully cultivated in Norfolk Island. The starch is separated in the usual manner, in the months of September and October, and is found to be of superior quality.

Cayenne pepper, manufactured from pods of the *Capsicum* grown in these gardens, has a quality and flavour equal to any that can be obtained. It is much in demand.

The Sugar-cane is seen in many places growing luxuriantly, but quite neglected. The first settlers introduced the plant, and made rum of its juice. Under the subsequent regime this distillation was forbidden, and hence the cane became valueless.

Garden fruits, though varied and abundant, are not always of good quality. The banana, strawberry, and grape grow freely, and may be cultivated to advantage. Raspberries grow vigorously, but do not fruit. The apple also fails, chiefly through blight. There are inferior qualities of pineapple, fig, olive, pomegranate, almond, quince, melon, and peach. The loquat, originally derived from Japan by the way of Batavia, is rather plentiful during the season; as well as the passion-fruit. Orange and citron plants, introduced from Sydney, are now just beginning to bear; but it is considered doubtful whether the walnut and mulberry trees, brought by Mrs Maconochie, will ever yield fruit.

Wild fruits are abundant in the Bush; limes and lemons may be gathered all the year round. The apple-fruited guava is everywhere plentiful, as well as the *Physalis edulis*, or Cape gooseberry. A few orange trees may also be met with. There is a tradition that the fruit of this tree was once so abundant, and offered so much sustenance to absconders, that the then commandant (Major Morrisett) ordered them to be extirpated. Upon careful inquiry I find this statement incorrect. Oranges never were abundant. An attempt was once made to destroy the wild guava and lemon trees; but their abundance at the present day proves that the effort was abortive.

It may be concluded from the preceding observations, that Norfolk Island offers every facility to the settlement and welfare of a limited community. The chief want is that of a harbour. But this might be supplied readily at a place called Ball's Bay, a mile or two eastward of the settlement. A profitable fishery might there be established. Many more tropical or semi-tropical plants, such as the real bread-fruit, coconut, yam, and mango, might be introduced; while the proper cultivation of those already there would yield surplus supplies for exportation. Coffee, maize, sugar, cotton, arrow-root, castor-oil, and cayenne have hitherto yielded well, even with forced unwilling labour and manual industry. Much more may therefore reasonably be expected from steady perseverance, aided by all the appliances of modern husbandry. It must not be forgotten, however, that the very prolificness of the soil offers great temptations to indolence; and that, unless this vice be steadily resisted, the most virtuous people will rapidly, both socially and morally, degenerate.—*Transactions of the Royal Society of Tasmania.*

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3. Transactions of Tyneside Naturalists' Field Club. Vol. V. Part III.—*From the Club.*

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